

CHEMICAL ENGINEERING

August 21, 1961

Graw-Hill Publication / Published every-other-Monday / Seventy-five cents

68.17

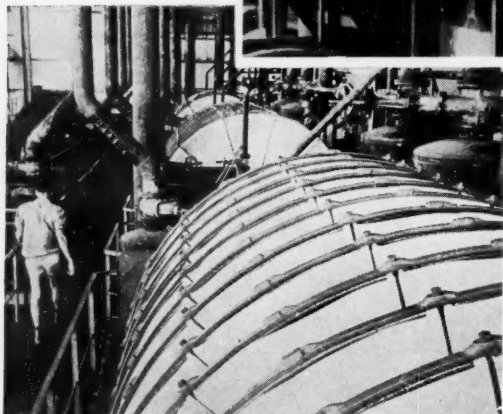
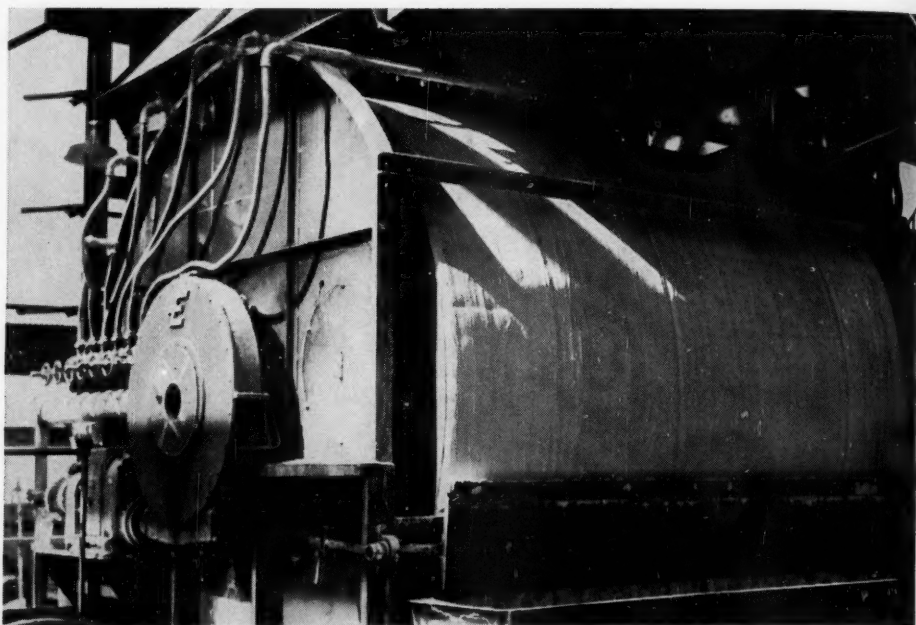


**How corrugated plastic
controls pollution (p. 70)**

complete contents: p. 3

13

EIMCO Filters at FRIA



Handle Record Tonnages in New African Plant

FRIA, an organization owned by Pechiney, France; Olin, U.S.A., and several other European aluminum companies, operates one of the world's largest alumina plants in West Africa. The huge plant employs 13 Eimco filters.

A battery of 11½-ft diameter by 12-ft. Eimco drum filters dewater and wash final alumina tri-hydrate crystals. Each is equipped with special multiple wash headers, for highest washing efficiency, and streamlined Eimco Hy-Flow valves for handling an exceptionally high flow with negligible hydraulic loss. An E-Vac air sweep, built into each filter's hydraulic system, eliminates filtrate blow-back, assuring low cake moistures.

The high performance achieved by these filters is a result of cooperative engineering in pilot plant and design stages. FRIA and Eimco engineers worked as a team on equipment design, were guided by past experience in engineering equipment for similar difficult filtration problems.

For the FRIA process, seven 12½-ft. by 12 disc Eimco Agidisc filters were custom-designed for handling huge volumes of caustic liquor, in dewatering hydrate seed. Eimco Hy-Flow valves enable these filters to dispatch the required flow with minimum hydraulic loss.

Ask your nearby Eimco representative for details.

Write Eimco Filter Division for Bulletin PE-2049.

The EIMCO corporation

Head Office: Salt Lake City 10, Utah, U.S.A.
Export Office: 52 South St., N.Y.



"Advanced Engineering and
Quality Craftsmanship
Since 1884"

Hy-Flow, E-Vac and Agidisc are trademarks of The Eimco Corporation.

B-647



It's a juicy job for Koroseal

ENGINEERS at this frozen food plant needed pipe that could keep fruit juices flowing continuously—and virtually automatically—through various processing stages. Metal pipe was out of the question. Citric acid would corrode it.

The answer? Pipes and fittings made of Koroseal rigid PVC by B.F. Goodrich. Nothing can corrode Koroseal. It's unaffected by acids, alkalies, salt, alcohol and just about everything else that ruins other pipe. Koroseal doesn't react chemically. It's odorless, non-

toxic, so there's no danger of product contamination.

Since Koroseal pipe weighs only $\frac{1}{4}$ as much as steel, it's easier and faster to install. It threads easily, can be cut, welded or drilled. It'll never rust, never need painting.

After three seasons' service, the owner of the packing plant had this to say: "Koroseal has met every one of our requirements. Not only was the installation economical, but we achieved the durability and sanitation that was so necessary. Our juice han-

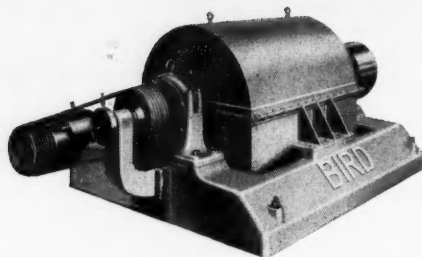
dling operation runs 24 hours a day, and we haven't had to shut it down once because of a pipe or fitting failure".

More and more companies are finding B.F. Goodrich Koroseal PVC pipe ideal for use wherever corrosion resistance, economical installation, minimum maintenance and long life are deciding factors. If you'd like to know more about Koroseal's advantages, call your nearby BFG distributor or write to us for a free booklet. *B.F. Goodrich Industrial Products Co., Dept. M-167, Akron 18, O.*

Koroseal—T.M. Reg. U.S. Pat. Off.

Koroseal rigid PVC products by

B.F. Goodrich



IMC* XXIX

*International Minerals & Chemical Corporation

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Bird

Continuous Centrifugals

Twenty-nine Times

Consistent with the rapid expansion of this great company has been their consistent employment of Bird Centrifugals.

36 Birds are now operating in 9 IMC plants. This includes six different size Birds on a multitude of solid-liquid separations.

What does this mean to you? Simply that no company would make such an investment over a long span of years unless the equipment offered indisputable evidence of profitable performance and long run economy.

Before *you* invest in solid-liquid separating equipment, it will pay you to investigate this Bird. Pilot scale test data is readily obtainable at the *Bird Research and Development Center*.

BIRD MACHINE COMPANY
SOUTH WALPOLE, MASS.

BUILDERS OF THE COMPLETE LINE OF SOLID-LIQUID SEPARATING EQUIPMENT

Operators of the *Bird Research and Development Center* for pilot-scale testing to determine the correct equipment for the job. Yours to use.

Application Engineering Offices EVANSTON, ILL. ATLANTA, GA.
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CHEMICAL ENGINEERING

August 21, 1961

CHEMICAL TECHNOLOGY FOR PROFIT-MINDED ENGINEERS

WHAT'S HAPPENING

COVER PHOTO: Striking arrangement pictured is new polyvinyl chloride packing now operating for first time in giant trickling filter at Rome Kraft Co., Rome, Ga. Story on p. 70.

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PRINT ORDER FOR THIS ISSUE 53,006
VOLUME 68, NUMBER 17

Chemical Engineering (with Chemical & Metallurgical Engineering) is published biweekly by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948), Founder.
Executive, Editorial, Circulation and Advertising Offices: 330 West 42nd St., New York 36, N. Y.
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Subscriptions: Send correspondence and change of address to Fulfillment Manager, Chemical Engineering, 330 West 42nd Street, New York 36, N. Y. Send notice promptly for change of address, giving old as well as new address. Enclose an address label from a recent issue of the magazine if possible. Allow one month for change to become effective.

Postmaster: Please send form 3579 to Chemical Engineering, 330 W. 42nd St., New York 36, N. Y.

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how to meter acids accurately against pressure

CORROSIVE liquids present two major obstacles to achieving maximum metering accuracy, economy, and safety. For one thing, corrosion can introduce an intolerable ever-changing volumetric error. For another, leakage can endanger personnel and necessitate the premature replacement of pump parts and associated equipment.

But both obstacles can be successfully overcome. First by choosing the right pump for the metering job at hand. Second, by making sure that all wetted parts of the pump chosen are inert to the liquid being metered. Here are some ideas based on practical acid metering experience that may help you to choose the best controlled volume pump for your metering needs.

Packed Plunger Pumps

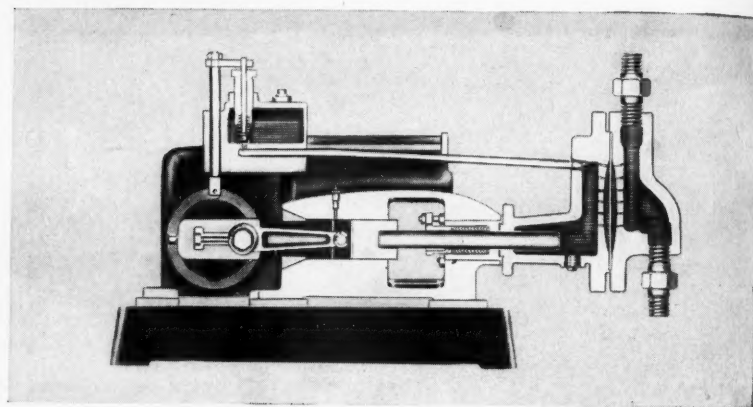
For the majority of mildly corrosive liquids, low cost packed plunger pumps have proved themselves entirely adequate. Some thirteen materials of construction are standard on packed plunger pumps, running from cast iron to Hastelloy B and C, more than enough to satisfy mild corrosive metering requirements. Capacities to 2056 gph, pressures up to 50,000 psi.

An added tip: Standard Milton Roy motor driven pumps in corrosive service can be equipped with "catch-all" yoke type gland followers.

Diaphragm Liquid Ends

When the liquid to be metered is highly corrosive or otherwise dangerous, a controlled volume pump with diaphragm liquid end is the best choice. A plastic or stainless steel diaphragm positively separates the process liquid and the plunger. The plunger displaces a hydraulic fluid which in turn strokes the diaphragm to create pumping action through the ball checks. Consistently high accuracy is achieved through unique design features. As the illustration shows, positive mechanical action bleeds any air or vapor from the hydraulic side between strokes and corrects liquid volume if necessary. Internal liquid end design also automatically eliminates bubbles from the process liquid side.

Very often, a pump chosen for mild corrosive service is obsoleted



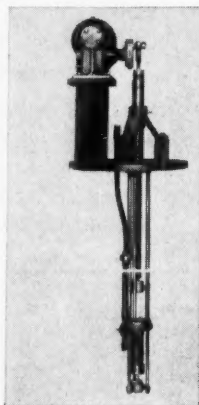
Controlled Volume Pump With Diaphragm Liquid End

by a process change specifying a more highly corrosive liquid. The diaphragm liquid end illustrated can easily be substituted for the conventional liquid end on any standard motor driven controlled volume pump, bringing the entire metering system up to date at little extra expense. *Designs of this type will handle up to 400 gph against heads to 2700 psi.*

Totally Immersed Liquid Ends

Acids with high vapor pressure or high specific gravity require the Mersemetric® controlled volume pump. Pump drive and motor are mounted on the tank top, but the liquid end is completely submerged to a depth of up to fourteen feet. This same design feature also eliminates the need for tank connections below liquid level, and permits chemicals to be metered directly from storage.

The maximum safety - minimum handling Mersemetric design is just about standard for metering sulfuric acid for demineralizer regeneration and pH control of cooling tower water and deaerator effluents. *Capacities up to 218 gph, pressures up to 1200 psi.*




The Acid Metering System

You can be fairly sure of making the right choice only if you consider all the factors. Here are several points that are often overlooked:

- Is the entire system corrosion-resistant . . . storage tank, suction and discharge piping, controlled volume pump, and relief valve?
- Thoroughly consider the physical properties of the liquid. High vapor pressure or high specific gravity liquids may demand a suction head.
- Consider plant and personnel safety under all possible conditions.
- Consider maintenance as well as first cost in determining the economics of the system.

If precision pumping of dangerous chemicals is one of your problems, look again to Milton Roy's 25 years of experience for your most economical solution. Write for a general introduction to controlled volume pumping in Bulletin 553-1. Milton Roy Company, 1300 East Mermaid Lane, Phila. 18, Pa.



milton Roy

CHEMICAL INSTRUMENTATION SYSTEMS

Controlled Volume Pumps

Colorimetric Analyzers

Hydrogen Purifiers

Laboratory Instruments

1936-1961

25

YEARS

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highlights of this issue

RADIATION AVAILABLE FOR PROCESSING

Got any chemical processes that could be economically triggered with gamma radiation at \$1.20/kwh.? Low-cost by-product radiation will soon be available from the new Hallam sodium-graphite reactor. E. G. Lowell, chemical engineer with Atomics International, presents here (p. 107) an economic analysis of chemical processing possibilities based on radioactive Na-24 from the reactor's primary cooling circuit.

BULLISH OUTLOOK SIRES METHYLAMINES BOOST

Rohm & Haas's new methylamines unit at Philadelphia is featured in our Process Flowsheet (p. 100). Although methylamines go into many other chemicals, big potential outlet is for making unsymmetrical dimethyl hydrazine rocket fuel, a derivative of dimethylamine.

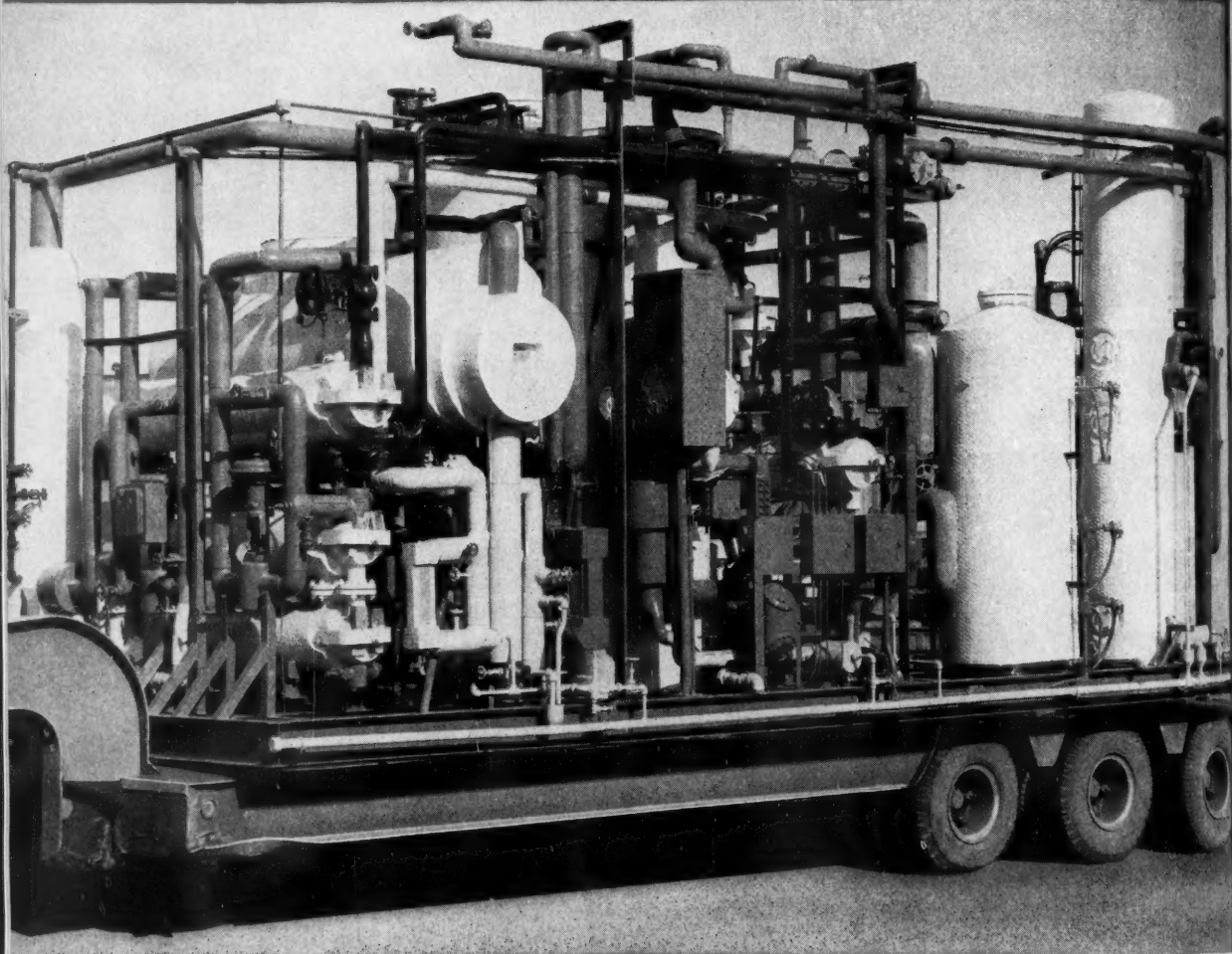
UNIFYING BASIC TRANSFER THEORIES

Study of transport phenomena provides a fundamental insight into the principles underlying chemical engineering unit operations, since transfer of heat, mass and momentum all follow similar laws. Now beginning (p. 126) is a four-part Refresher series on this basic subject, written by L. D. Smoot, assistant professor of chemical engineering at Brigham Young University. If you're rusty on your chemical engineering science, here's your chance to brush up.

THE CPI LOOKS AT EQUIPMENT LEASING

Any business growing at a rate of 40%/yr. justifies close analysis. That's why Operation & Maintenance Editor Herb Popper looked into the booming business of equipment leasing (p. 136). Here's what he found: "Looking at the chemical equipment field as a whole, nobody expects leasing to overshadow purchasing, but it may become considerably more popular."

NEW package hygirtol® plant offers low cost hydrogen production



This compact but complete hydrogen package plant is available in a production range of 5,000 to 25,000 C.F.H. If you now purchase hydrogen or produce it by an obsolete and expensive process, a new Girdler plant will quickly pay for itself by its low production cost. Girdler Compact Hydrogen Plants manufacture high-purity hydrogen from hydrocarbons and steam, and combine the same continuous

chemical processes that have made Girdler's field-erected hydrogen plants so well accepted throughout the world. Other Girdler Hygirtol plants are available to suit the very highest volume users. For a complete description of the Girdler process for high purity hydrogen production, write for comprehensive bulletins which include complete descriptive data and flow-sheets.

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SUBSIDIARY OF THE CHEMICAL & INDUSTRIAL CORP.

designers and constructors of plants for the production of: Hydrogen ■ Carbon Monoxide ■ Carbon Dioxide ■ Ammonium Nitrate ■ Hydrogen Sulfide ■ Ammonia ■ Synthesis Gases ■ Hydrogen Cyanide ■ Anhydrous Hydrogen Chloride ■ Formaldehyde ■ Girdletol Gas Purification ■ Sulfur Recovery ■ Urea

New communications center serves CE readers



Focal point of McGraw-Hill's world-wide news-gathering network is this enlarged communications center recently installed in our headquarters building. Dispatches coming into New York from our own field editors, as well as from reporters in major cities in the U. S. and around the world, flow almost continuously from these 19 teletype and cable machines to the desks of CE's news editors and thence, via our news columns, to you.

Sulfuric Acid Plant Costs

Sir:

In your Mar. 20 Cost File there appears on p. 184 a graph of plant investment vs. capacity for sulfuric acid plants.

What is the basis for the costs? Are they turnkey battery-limits costs, or do they represent plants complete with normal non-process (off-site) facilities?

Slope of the curve appears greater than what our cost experience would indicate to be normal. Our data on a number of plants shows a 0.61 slope, which checks closely with the 0.6 power brought out by Duecker and West ("Manufacture of Sulfuric Acid," p. 239, Reinhold, 1959).

J. H. JENSEN

Western Knapp Engineering Co.
San Francisco, Calif.

Sir:

The nature of the plants covered in our study was primarily "new producing units located within a previously developed plant site."

We did not have enough information on sulfuric acid plants to cover the other two project classifications (new grass-roots plants and enlargement of existing units), as was done in a few of our other curves.

Slope of the line, which we showed as about 0.90, was simply the result of plotting costs for a number of plants for which we had what we considered to be reliable cost information. We note that Chilton ("Cost Engineering in the Process Industries," p. 282, McGraw-Hill, 1960) shows a factor of 0.63 for sulfuric acid made from sulfur and 0.91 for sulfuric acid made from smelter gas. However, I must admit that our studies were essentially devoted to acid made from sulfur.

It has been my personal experience that any production increase in a given plant always required a considerable expenditure, since most of the avenues of process techniques have been fairly well explored. Within the past ten

years or so the trend has been to a more concentrated burner gas (up to 12% SO_3), coupled with more gas cooling equipment, which in turn should improve the conversion.

I would imagine that the effect of this type of improvement would be to lower the slope of the curve, and I certainly do not wish to oppose those whose experience in the field shows that the slope is lower than our 0.90. An important intangible cost item which we sometimes find baffling is a good definition of capitalized costs vs. expensed items.

All in all, I am gratified by any response from your readers which can help clarify the oftentimes nebulous field of project cost estimation.

JOHN E. HASELBARTH

Pritchard & Abbott
Houston, Tex.

Pro: CE's Dual Value

Sir:

Congratulations! I've thought of saying this many times but up till now have not put it in writing.

A publication is valuable if it provides its readers with timely, authoritative subject matter. This you do.

It is even more valuable when the subject matter can be easily removed from the magazine and preserved. Your binding and layout techniques are both close to 100% perfect in this respect. Such practices as ads and editorial on reverse sides of the same leaf make filing your material much simpler.

I, for one, appreciate these features, and I'm sure many others do also.

STODDARD H. KNOWLES

Hornblower & Weeks
New York, N. Y.

Price vs. Market

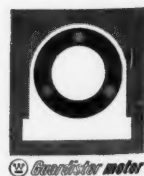
Sir:

In your May 15 issue (p. 86) you were kind enough to mention the availability of one of our recent

Continued on page 184

The Westinghouse man with the motors brings you—

New Class B Insulation to give you 15% more horsepower on totally-enclosed Life-Line motors





Now Class "B" Insulation replaces Class "A" as standard on totally-enclosed 1-250 hp Life-Line a-c motors giving you these advantages:

Added capacity . . . Operation at 15% over name-plate rating without reduction in motor life.

Longer life . . . 80% to 100% longer life at rated loads than motors with Class "A" Insulation.

This newly designed motor is engineered to give top performance in a wide range of applications. On-the-line experience in the steel industry, where maximum reliability is essential, has proved its higher output, longer life and lower maintenance under the toughest conditions.

For the ultimate in protection specify Guardistor* on all Westinghouse motors. This exclusive built-in static motor protection allows the use of maximum horsepower over long periods with no danger of motor burnout.† For additional information ask for booklet B-7876-A.

Your Westinghouse sales engineer can supply you with complete details on these money-saving motors. Call him for full information on how they can fit into your production scheme. Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pennsylvania.

You can be sure . . . if it's Westinghouse.

*Trademark

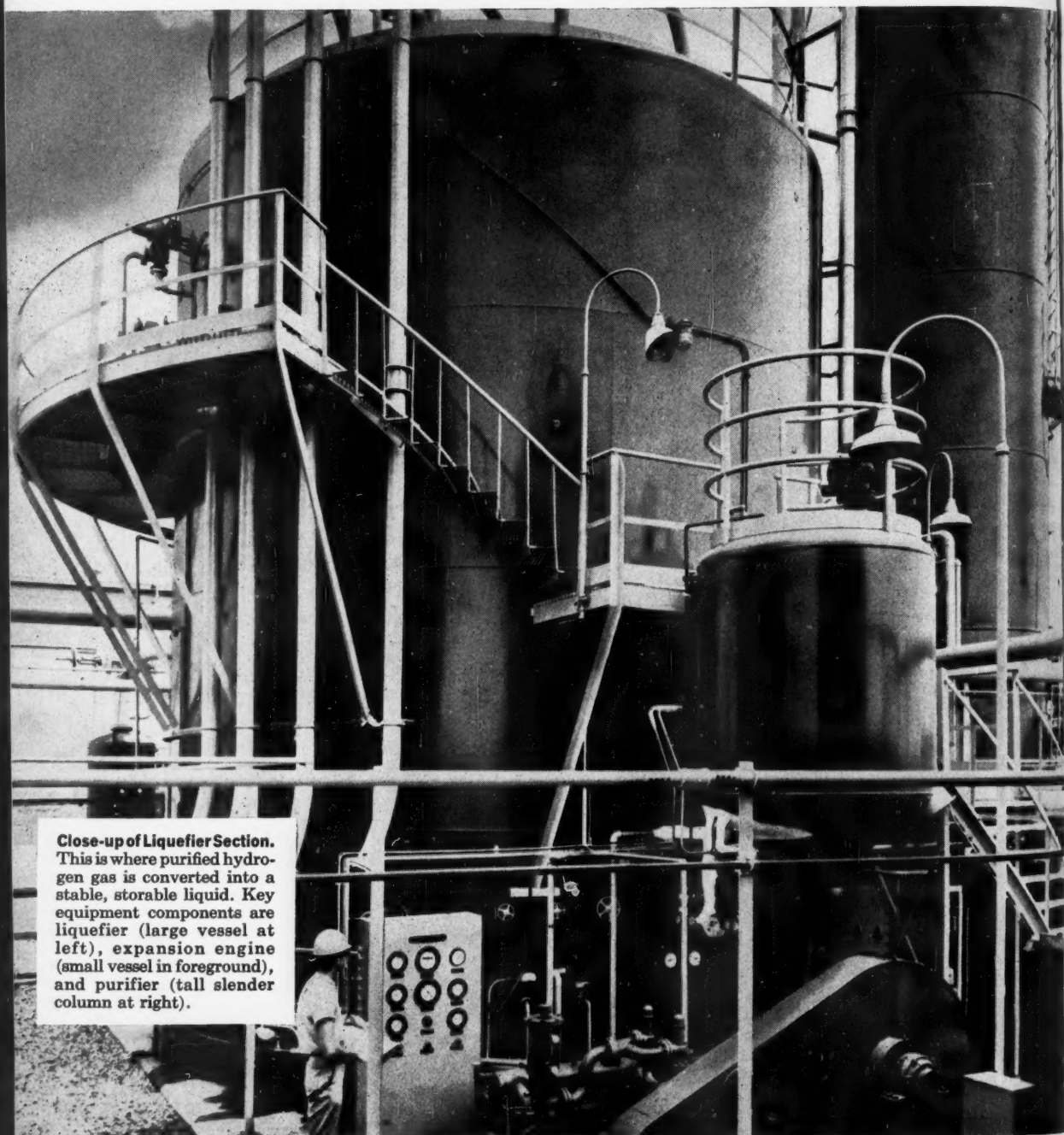
Westinghouse



†Warranty: Westinghouse GUARDISTOR MOTORS on frames 182-445 inclusive are guaranteed for one year against burnouts due to overheating resulting from: overload, locked rotor, blocked ventilation, bearing seizure, single phasing, unusual duty cycle, high ambient, or voltage unbalance, providing the Guardistor elements are connected in a control circuit so that the motor is removed from the power source in the event of over-temperature.

J-22170

LINDE COMPANY REPORTS... *Lower operating and* *Liquid H₂ with Trane Brazed Al*



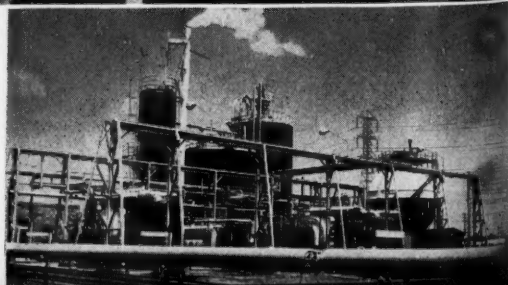
Close-up of Liquefier Section.

This is where purified hydrogen gas is converted into a stable, storable liquid. Key equipment components are liquefier (large vessel at left), expansion engine (small vessel in foreground), and purifier (tall slender column at right).

SPACE AGE PLANT. This multi-million dollar installation in Torrance, California, is the largest liquid hydrogen plant in the West—the second largest in the country. It is the second of five Linde plants operating or under construction primarily to meet the growing needs of the aerospace industry. And it is the first plant in the U.S.

to prove the feasibility of producing liquid hydrogen on a privately financed, commercial basis.

An important aspect of Linde's operation lies in handling the ultra-cold product. All piping downstream from the converter is vacuum-insulated, keeping heat leak to under 2 Btu./hr. per linear foot.



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and installation costs in producing Brazed Aluminum Heat Exchangers

14 compact heat exchangers operate under pressures from 15 to 850 psig...temperatures down to -423°F

The new Torrance, California plant of Linde Company—division of Union Carbide Corporation—went on-stream in mid-1960. It produces 13,000 lbs. of liquid hydrogen a day—and supplies West Coast missile development centers at the rate of 3,300,000 lbs. per year under a contract awarded by the National Aeronautics and Space Administration (NASA).

Basics of the Linde process

TRANE Brazed Aluminum Heat Exchangers are used in both the purification and liquefaction phases. Entering feed gas at 250 to 300 psig. is approximately 35% hydrogen. After it has been processed through TRANE Heat Exchangers, condensers, separators and an activated carbon adsorber, the impurity level is under 2 ppm.

When the hydrogen stream exits from the compression cycle at 850 psig., 90°F , it is ready to be cooled to liquefaction temperature. Two-step initial cooling brings the gas down to -315°F . Further cooling takes place against liquid nitrogen that is below atmospheric pressure—and final processing through an expansion valve brings the hydrogen down to -423°F where a portion of it liquefies. This liquid hydrogen is converted from ortho to para form, is sub-cooled, and is ready for storing and shipping.

WANT MORE FACTS? Ask your nearby TRANE Sales Office for more complete information on TRANE Brazed Aluminum Heat Exchangers. Or write TRANE, La Crosse, Wisconsin.

Lightweight, Compact, Rugged! TRANE Brazed Aluminum surface consists of corrugated aluminum sheets brazed together to form a stack of layers that provide individual passages for the flow of gases or liquids. Provides up to *nine times* the surface per cubic foot of shell-and-tube exchangers!

Why Linde chose Trane

TRANE Brazed Aluminum Heat Exchangers were specified because Linde wanted a dependable, compact heat exchanger surface that would give superior performance at extremely low operating temperatures. These are the same reasons more and more companies in cryogenics are turning to TRANE.

Close Temperature Approaches. Approaches within 2°F could be attained with these TRANE Heat Exchangers.

Low Installation and Space Costs. A typical TRANE unit requires only *half as much space* as conventional heat transfer equipment. And this, of course, means less insulation is needed.

Low Operating Costs. The compactness of TRANE Brazed Aluminum minimizes the cost of refrigeration at the extremely low temperatures required.

Trouble-Free Operation. TRANE equipment is backed by thirty-two years of specialized heat transfer experience; 10 years of proved performance with Brazed Aluminum Heat Exchangers in process applications.

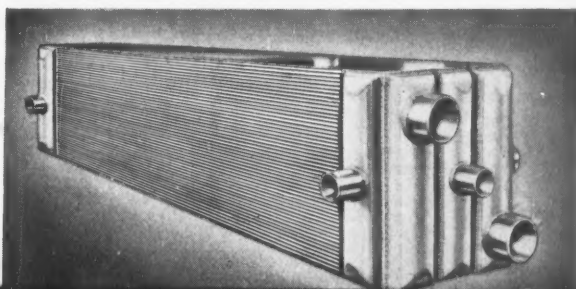
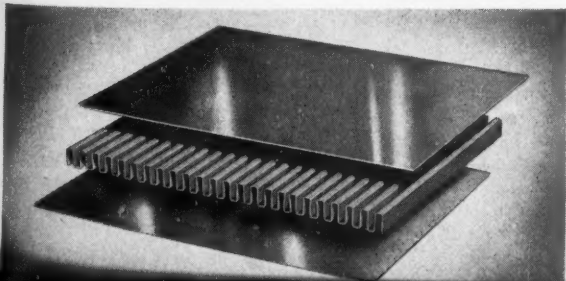
For any air condition, turn to

TRANE

*Manufacturing engineers of air conditioning,
heating, ventilating and heat transfer equipment*

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100 U.S. AND 18 CANADIAN OFFICES

Headered for 5-Stream Operation. The TRANE Brazed Aluminum Heat Exchanger can handle as many as five fluids simultaneously. Units are available for either cross-flow or counter-flow operation. Surface can be fabricated in a wide variety of shapes and sizes to meet all types of specifications.



FISCHER & PORTER

INSTRUMENTS THAT MEASURE AND CONTROL TEMPERATURE, PRESSURE, FLOW, ETC., ETC.
Have established and maintained their reputation for superiority against all competitors
through the years and are increasing demand. In the past, it is the unalterable
DETERMINATION OF THE HOUSE TO SEND OUT NOTHING BUT WHAT IS OF
THE HIGHEST POSSIBLE QUALITY

Centralized Control with Fischer & Porter Instruments

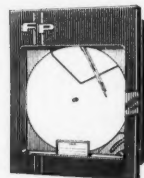
In the recent past, we have been beset by the taunts of skeptical fellows, who allege that we are naught but THE FOREMOST MAKER OF FLOWMETERS! To this allegation, we reply vehemently, "NOT SO"—and we have the fortitude to present proof of an exceedingly cogent nature to support our earnest denials. Proof, if you will, that the bonds of our PROCESS INSTRUMENT LINE extend far beyond the limits of our justly renowned flowmeters—to a multiplicity of transmitters AND a complete selection of PANEL instruments. Consider, if you will that we offer process instruments to measure, NOT MERELY FLOW, but temperature, pressure, liquid level, viscosity, density, pH, ORP and a great miscellany of secondary process variables. We invite your attention, in particular, to the extraordinary number of our divers devices that are available to convert the output of these multitudinous instruments to clear, accurate and repeatable signals and to transmit them instantaneously to the very heart and core of the system—that is, the CONTROL CENTER.

Again NOTE the multiplicity of these precision mechanisms diligently performing their as-

signed tasks at the CONTROL BOARD. Witness the amazing array of large and small case panel instruments, some with pointers, others that pen a record, with controllers secreted within (or with miniature instruments, ingeniously affixed in the rear). The number and variety of these equipments verily BEGGARS DESCRIPTION.

Need we say more? Have we convinced you? If not, may we recommend that you spend a few felicitous moments with our new PROCESS INSTRUMENTATION BOOKLET Number 310, which—be advised—is a brief, conveniently condensed presentation of the more prominent of these astounding precision devices. Here, Sirs, is indisputable evidence that we are an INSTRUMENT COMPANY—indeed, more than that—a worldwide organization, priding ourselves on the development and manufacture of transmitters and BOARD instruments to fit ANY AND EVERY KINK in the knot-tiest control system. May we send you a copy for your perusal? Until the post accommodates your receipt of same, may we suggest a hasty review of the following sampling . . . ?

Versatile - Flexible - Adjustable



the
1100
Series

LARGE CASE 12" Chart

Recorder & Recording Controller

- Can record up to 4 variables!
- Can include TWO, 3-mode controllers!

Here, Good Sirs, is the HEAVY DUTY, GENERAL PURPOSE INSTRUMENT of the renowned F&P line! Its flexibility is unmatched. When employed as a RECORDER, it will receive up to 4—yes, FOUR!—separate and distinct signals from transmitters. As a controller it can contain two of the renowned Series 53-P, 3-mode controllers complete with gauges and regulators! And—great boon to servicers—it has a sealed inking system—guaranteeing positive records, day after day.

COMPACT & MIGHTY

The Medium-Sized 1450 Series
FIBER GLASS CASE

Indicating Receiver & Controller
with 6 control mode options!

When records are not required, but GOOD READABILITY of the scale is important, the Fiber Glass Case Instrument with its 5 inch scale is pronounced by many who use it as the FINEST OF ITS KIND. It has the GREATEST

variety of control options in the industry. Amazingly, SIX different types of control are available—from on-off through three-mode! And it utilizes the same superb 53-P controllers used in ALL types of F&P instruments. This means true INTERCHANGEABILITY—and results in lowered INVENTORIES.



The exterior of this versatile instrument is formed of the new corrosion resistant FIBER GLASS material, and the door is gasketed with tenacious polyvinyl chloride. When panel space is lacking, another pointer can be added to measure an ADDITIONAL variable. Also, this device can be used as a field-mounted instrument—with control or transmission at the very point of measurement.

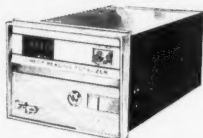
In-Case Alarms

When it is desired to alert the operators should an UPSET in the process occur, the clever In-Case Alarm System can be supplied. No extra black boxes—no additional exterior parts. This transistorized alarm option fits within the case and provides adjustable differentials from $\frac{1}{2}$ to 15% of full scale.

{ The same system can also be supplied with the 1100 Series LARGE CASE Instruments. }

! NEW! NEW! NEW!

Transistorized Pulse Receiving
2800 Series



DIGITAL DEVICES

These are the advanced devices which have ushered in whole NEW CONCEPTS in the fine art of instrumentation. FULLY TRANSISTORIZED printed circuitry, keyed plug-in boards, direct-reading measurements—are but some of the features of this new line of modern instruments which can be made to indicate, totalize, record digitally and control. They accept signals from any frequency generating device and convey data in pulse or direct reading digital form. The latest application of these futuristic instruments is with the renowned F&P CONTINUOUS IN-LINE SYSTEMS which blend two or more fluids right in a pipeline.

Truly Amazing! MINIATURE Case INDICATORS * RECORDERS * CONTROLLERS

Lilliputian magicians that can solve the TRICKIEST CONTROL PROBLEMS... yet fit the tightest graphic panel!

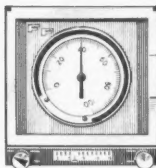
Here is a tabulation of the fabulous family of MINIATURE INSTRUMENTS which handily accomplishes every control feat of the bigger conventional units and, that notwithstanding, solve the panel designer's dilemma. These tiny

devices require only 6" x 6" (we reiterate—only six inches by six inches) MAXIMUM PANEL AREA, yet are simply serviced by BIG-THUMBED PERSONS as all parts are readily within grasp for easy adjustment.

Consider this BROAD SELECTION of basic units...

Dial-type Indicator 1200 Series

Dial is $3\frac{1}{2}$ " diameter—a handy control station that operates with either a plug-in or field-mounted controller and for LOCAL or REMOTE set point adjustments.

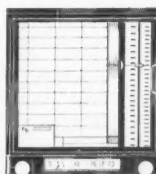


Strip Chart Recorder 1200 Series

Records up to THREE VARIABLES on a 4" chart with 14-hour visible record. Gasketed metal or plastic door. Can be equipped with a plug-in or field-mounted Model 53-P controller.

Drum-type Indicator 1300 Series

Indubitably clever! The drum rotates so the TRUE VALUE is always at the center of the gauge for long distance observation. Can be equipped with high or low limit ALARMS.



Indicating Integrator 1200 Series

Provides PRECISE flow rate totalization on an 8-DIGIT counter while the input variables are indicated SIMULTANEOUSLY on a $2\frac{1}{2}$ " vertical scale. Surely the way to integrate!

state your pleasure, gentlemen!

To better acquaint you (or your colleague) with the BENEFITS and ADVANTAGES of our products we have caused to be printed informative literature for the general edification. We will gladly post to you a selection of these works upon your application, or have a field engineer call you for an appointment. Make a selection of your pleasure from the appended list. Inscribe your name and address in the generous space provided and send post-haste to us.

Fischer & Porter Co.

1075 Centre Line Road, Scarborough, Pennsylvania 15142, Canada
A world-wide INSTRUMENT COMPANY with plants in Australia, Canada, England, France, Germany, Holland, Mexico, as well as the U.S.A.

☐ Send Booklet No. 310, "Process Instrumentation"

Please post information on: ☐ LARGE Case Instruments ☐ FIBER GLASS Case Instruments
☐ DIGITAL Instruments ☐ MINIATURE Drum Indicator ☐ MINIATURE Case Dial Indicator
☐ MINIATURE Strip Chart Recorder ☐ MINIATURE Indicating Integrator
☐ Have your FIELD REPRESENTATIVE call.

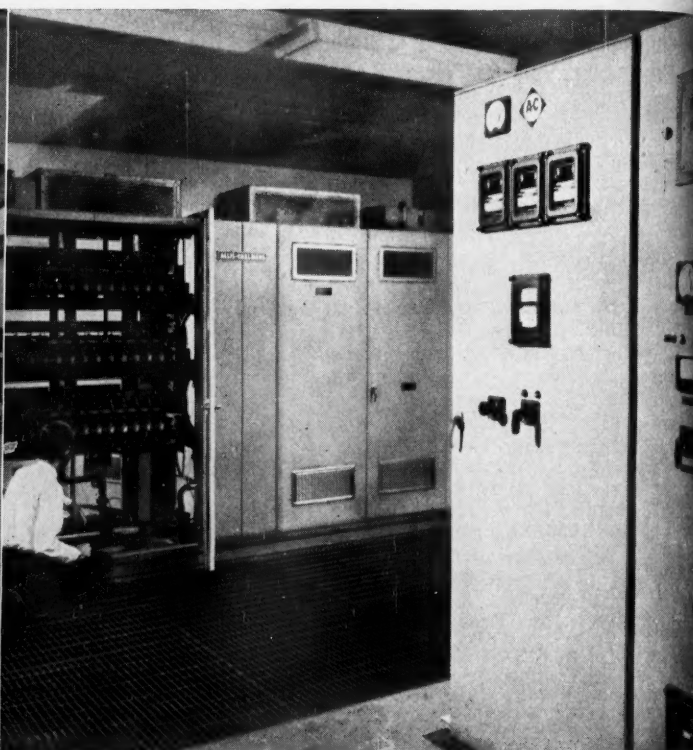
NAME & POSITION _____
COMPANY _____
ADDRESS _____
CITY _____ ZONE _____ STATE _____



ideas and news:



Up to 35 square feet of screening area in only 16 square feet of floor space: Stacked-deck design of this gyratory screen conserves valuable space. Cuts maintenance, downtime with all-stainless-steel construction. Abrasive or corrosive materials, dry foods and pharmaceuticals are handled with care. Gentle, quiet, vibrationless operation means minimum disintegration of fragile particles.



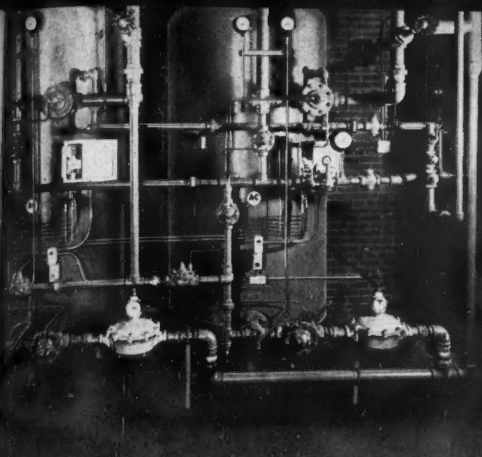
Silicon rectifiers can be located anywhere in the plant. Designed especially for large electrochemical or industrial applications where space, heat or dirty atmospheres are a problem, these silicon rectifiers employ water-to-water heat exchanger equipment. No special room is required — no need for clean air for cooling. Smaller compartment sizes save floor space. Cells can be removed without disturbing the cooling system. Reactor cores eliminate need for matched cells, surge capacitors protect against voltage surges, and current-limiting fuses provide cell protection.

Which of these productive ideas could be working for you?

A continuous mechanical agglomeration process that makes waste materials pay. A steam turbine-generator with dual-purpose flexibility. A gyratory screen that saves space. These examples demonstrate the extra value that is standard with Allis-Chalmers . . . the greater efficiency and the added productivity which are yours when you buy A-C products, systems and services. Call your Allis-Chalmers representative for details on A-C "worth-more" features. Or write Allis-Chalmers, Industries Group, Milwaukee 1, Wisconsin.

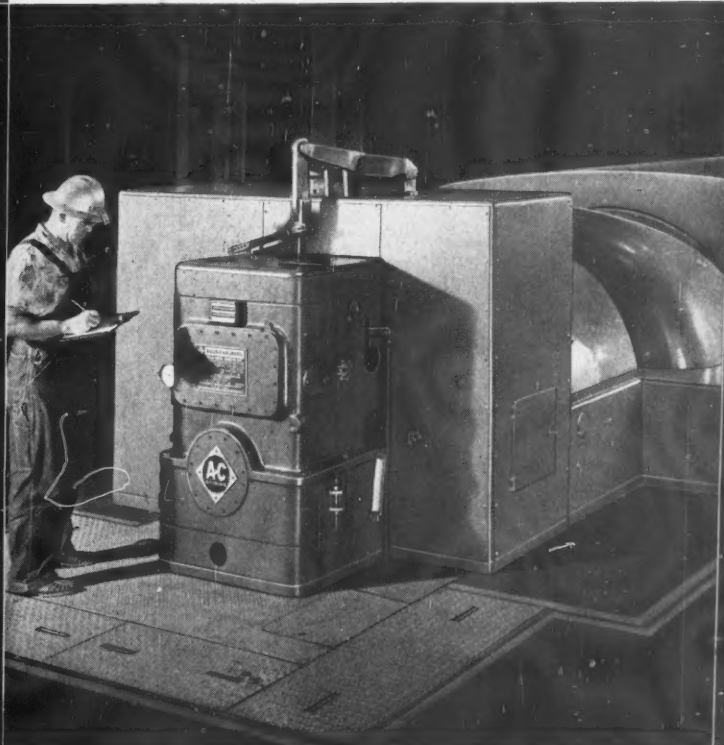
Compactor is an Allis-Chalmers trademark.

A-1490



Calcium and magnesium are the "vandals" that cause scale in pipes and boilers, clog systems and mean heavy use of cleaning compounds. ZEOLITE is their natural enemy! An A-C zeolite water softener means a simple switch to sodium ions from the usual hardness present in most water supplies. Once A-C conditioned, the "softened" water finds ready use in chemical plants to end scaling problems.

Even the by-product makes an economy contribution: Versatile . . . describes these two 6250-kw condensing, automatic extraction steam turbine-generator units installed in a mid-west petrochemical plant. A typical application supplying steam to a process with electric power as an economical by-product. A-C manufactures a complete line of condensing and non-condensing turbine-generator units, with or without automatic extraction, for the chemical industry. For complete information on types and ratings from 2000 kw to the largest, ask for bulletins 7654A and 9448.



Profit recovery starts with waste: The continuous mechanical compacting process recovers virtually 100% of waste fines! It compacts and screens your waste material into flakes. Then granulates them into desired product. The same process tightens your production controls when you face problems involving granular size, density, solubility and other physical properties. Integrates smoothly into your system. Requires less power, lower capital investment than less modern agglomeration methods.

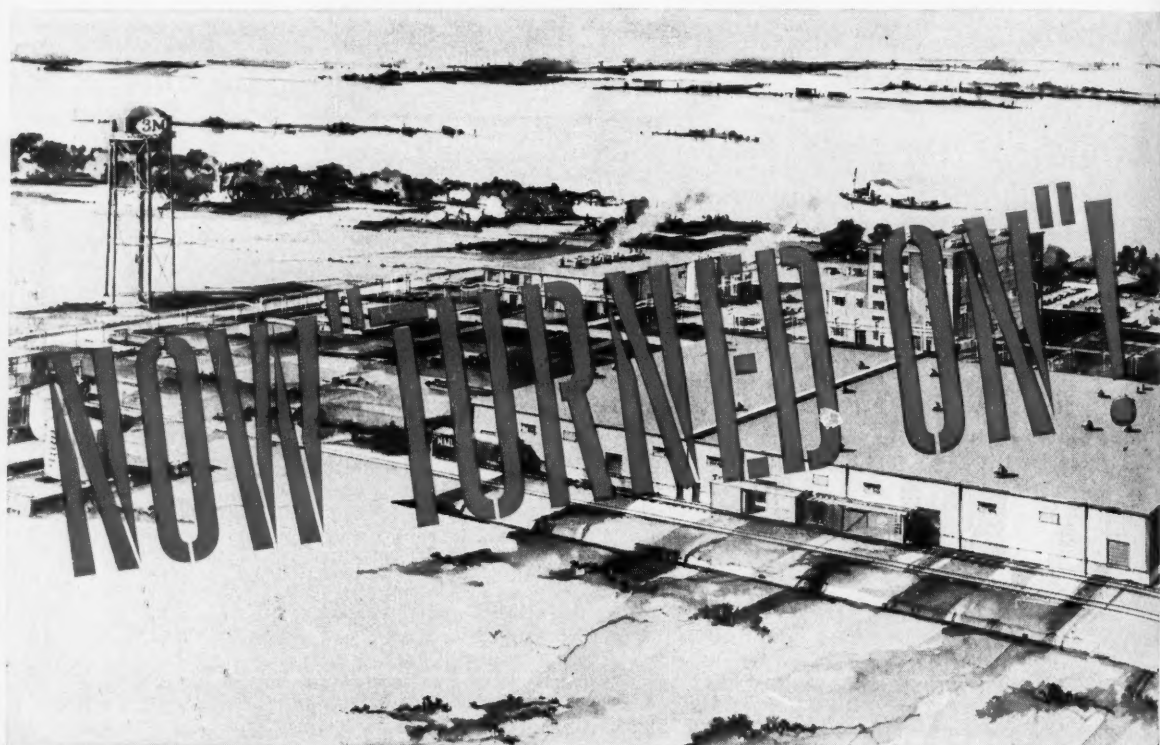
ALLIS-CHALMERS PRODUCTS FOR THE CHEMICAL INDUSTRY:

Look to A-C for atomic, thermal and hydro electrical generating equipment; Compactor mills; compressors; control; coolers; crushers; dryers; earth-moving equipment; engines; grinding mills; industrial systems; kilns; lift trucks; motors; pumps; rectifiers; screens; switchgear; tractors; transformers; unit substations.

ALLIS-CHALMERS



THE RAW MATERIALS OF PROGRESS



New 3M Fluorochemicals Plant! New KEL-F® 81 Brand Plastic!

New plant and plastic will provide quality uniformity with volume... many advantages for processors and users

The New Product

- KEL-F 81 Plastic... retains the excellent end-properties of the original, but offers completely new processing advantages made possible by new manufacturing techniques and facilities.
- KEL-F 81 Plastic features exceptional consistency and uniformity... *not only within each lot, but from lot to lot as well.*
- Molecular weight of KEL-F 81 Plastic is carefully controlled by today's most modern quality control methods and machinery.
- Consistency in processing conditions provides a further uniformity standard for KEL-F 81 Plastic.
- KEL-F 81 Plastic is available in several forms to provide highest adaptability to customers' processing.

The New Plant

- Now on stream at Decatur, Alabama... newest, most modern chemical plant devoted exclusively to the production of quality fluorochemicals.
- Latest processing and quality control equipment, designed by one of the pioneers in fluorochemistry and fluorochemicals production.
- Production versatility that can move swiftly from pilot stage to full production of products adaptable to a wide range of customers' needs.
- Entire operation specifically designed to ensure highest uniformity in 3M Fluorocarbon chemicals.
- An integrated system of rail, truck and waterway transportation will provide fast delivery for your fluorochemical needs.

The big new 3M plant alongside the Tennessee River is now on stream with high-volume quality production of 3M Fluorochemicals to meet the expanding demands of industry. Featured are . . .

New Processing Advantages

One of the major products to be produced by the new plant is "KEL-F 81 Plastic" . . . chemically similar to previous KEL-F products, but now available with substantial revisions in processing advantages . . . for use in many industrial applications . . . especially in electrical, electronic, aero-space, and many chemical processing plants as a resilient, dense thermoplastic molding material, with product improvements you will welcome. For example . . .

Assured Uniformity!

In 3M's new Decatur plant, every precaution has been taken to ensure the highest uniformity of quality for KEL-F 81 Plastic production . . . both within a lot and from one lot to another.

Qualified processors will be offering KEL-F 81 Plastic in a variety of physical forms, each tailored to specialty requirements of product or process. They will meet exceptional degrees of resistance to chemical attack, heat, cold, moisture, dielectric properties, etc.

Stepped-up Fluorochemicals Production

3M—Decatur not only will manufacture KEL-F 81 Plastic . . . it will produce the full line of chemical products carrying the KEL-F brand name . . . plastics, elastomers, dispersion coatings, greases, oils and waxes.

Accelerated Delivery!

A completely integrated network of transportation will serve the Decatur plant, help-

ing 3M give industry fast delivery of KEL-F Plastic and other products in the fluorochemical family. Railroad lead tracks and newly constructed highway arteries, with automatic loading facilities will speed these products to customers.

Technical Help!

3M technicians as well as a technically oriented sales force stand ready to provide practical technical help to manufacturers seeking to apply the advantages of KEL-F Halo-fluorocarbon Products to their applications. Their services (based on extensive field and laboratory tests) as well as 3M lab facilities and services of qualified processors will be available for help in overcoming problems involving the use of any of these products.

Production Assistance!

3M sales and lab representatives offer a wealth of experience with fluorochemicals, to assist qualified processors in setting up efficient production procedures to better serve your needs.

New Technical Brochure!

Just off the press—a brand new brochure giving complete technical data on KEL-F 81 Plastic. It contains complete laboratory and test data on the chemical and physical properties of KEL-F 81 Plastic, (also processing details) together with much practical data on its use in compression, injection, transfer, and extrusion molding. Please write on your company letterhead, indicating the nature of your interest.

Write: 3M Chemical Division,
Dept. KAL-81,
Minnesota Mining and Manufacturing Company, St. Paul 6, Minn.



Properties Profile

on KEL-F® 81 PLASTIC BRAND

KEL-F 81 Plastic is a fluorocarbon plastic, a thermoplastic resin formed by the homo-polymerization of chlorotrifluoroethylene. The high degree of fluorination of KEL-F 81 Plastic is responsible for its chemical inertness and thermal stability. The inclusion of chlorine in an otherwise carbon-fluorine molecule results in exceptional moldability and mechanical toughness.

Crystallinity. KEL-F 81 Plastic is crystallizable, but not necessarily crystalline, the degree and kind of crystallinity in a given sample being a function of its thermal history. The "quick quenched" resin is spoken of as amorphous, and the "slow-cooled" resin as crystalline. When crystalline, KEL-F 81 Plastic is a denser, more translucent material with higher tensile modulus, lower elongation, and greater resistance to the penetration of liquids and vapors. The amorphous plastic is less dense, more elastic, with greater optical clarity and toughness.

Physical Properties. The physical properties of KEL-F 81 Plastic combine mechanical, chemical, electrical, and optical advantages. And the most useful applications center around combinations of the following properties:

1. Useful temperature range: from -400°F. to +400°F.
2. Resistance to deformation and flow at high temperatures, pressures
3. Zero moisture absorption
4. Abrasion resistance
5. Radiation resistance
6. Chemical resistance
7. Electrical properties
8. Infra-red transmission
9. Inert to liquid oxygen
10. Flexible in contact with cryogenic fuels

Processing. KEL-F 81 Plastic can be processed in the same manner as other thermoplastic resins. Parts of KEL-F 81 Plastic may be specified in any form. However, because of time and temperature limitations, compression molding is the ideal method for retaining all of the desirable mechanical properties originally built into the basic polymer. Other processing methods, such as injection molding and extruding can be used to achieve the same degree of quality, but special attention to processing techniques is required to avoid excessive degradation.

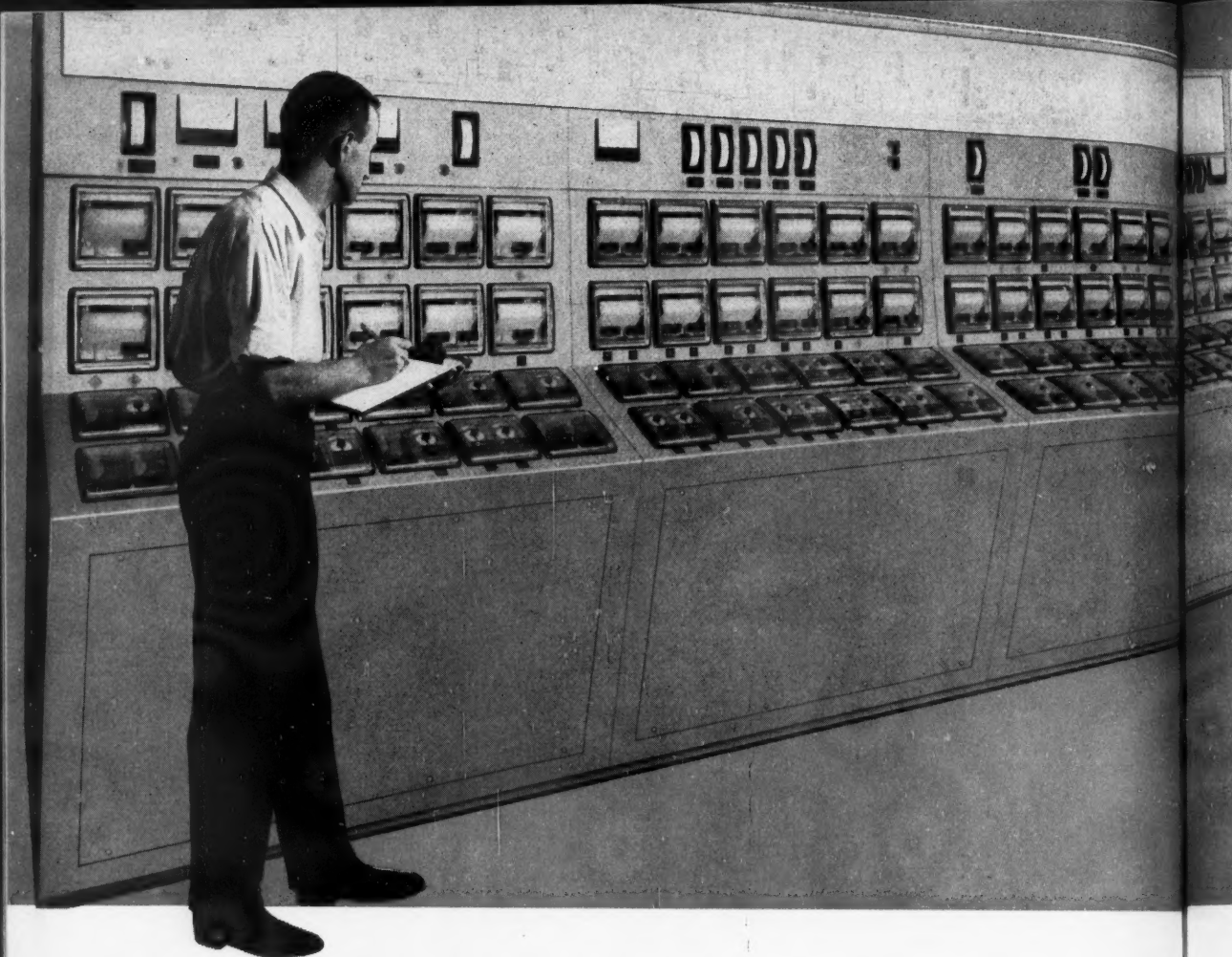
Detailed discussion of these various processing methods, as well as the finishing of parts is contained in the free brochure, offered in the adjoining column—write for it!

CHEMICAL DIVISION

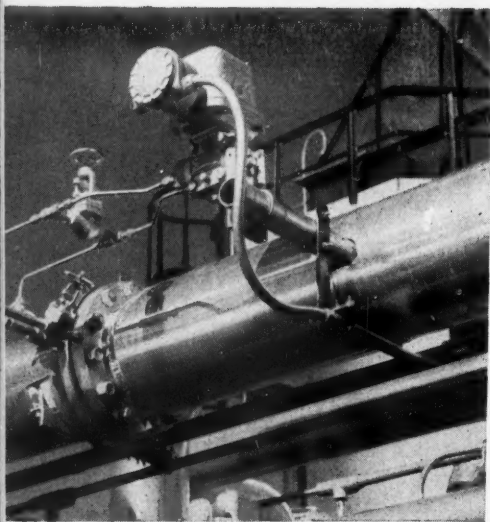
MINNESOTA MINING AND MANUFACTURING COMPANY

...WHERE RESEARCH IS THE KEY TO TOMORROW





Foxboro Electronic Consotrols* shrink

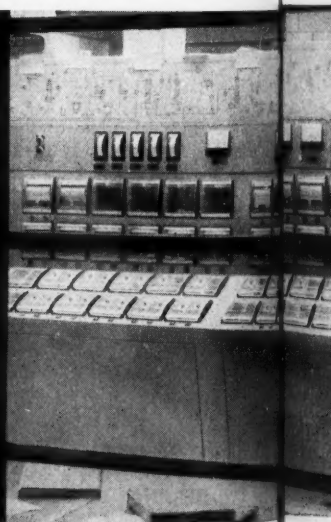


100% solid state instruments, like this Foxboro Type 613 d/p Cell* Flow Transmitter, were used in all control loops to assure instant transmission over long distances.

*Reg. U. S. Pat. Off.



Fifteen-foot Foxboro Electronic Console permits fast scanning of instruments — gives dependable control of Alkaf† unit, styrene plant, and steam plant for Cosden Petroleum.



†Universal Oil Products Co.
— Process Licensor
Badger Manufacturing Co.
— Contracting Engineers

k panel length 66% for Cosden Petroleum

Panel planned for 45 feet, then reduced to 15 feet with Foxboro "small case" Electronic Consotrols

Space saving has taken on a new meaning at Cosden Petroleum Corp. At Cosden's Big Spring, Texas refinery, an Alkar unit, a styrene plant, and a steam plant are all electronically controlled by one 15-foot Foxboro Modular Console.

When Cosden Petroleum specified Foxboro "small case" Electronic Consotrols and modular consoles, 30 feet of panel space were eliminated for a considerable saving in building construction costs alone.

What's more, Foxboro packed 61 Electronic Consotrol Controllers, plus 100 indicating and recording points into the 15-foot panel — and there's still room to spare for tomorrow's instrumentation needs! Spare panel cut-outs for 35 more controllers and 9

more recorders are pre-wired and ready for service. All Cosden needs to do is hook up the transmitter leads at the bottom of the cabinet and slip the recorder or controller into the panel.

Maintenance men also like the easy way they can transfer instruments on the modular console. Instruments slide in and out of their housings as easily as drawers. A simple plug-in connection puts the instruments into action.

You too, can save space, save time, save money — with Foxboro Electronic Consotrols.

Write for Bulletin 9-12. The Foxboro Company, 368 Neponset Avenue, Foxboro, Massachusetts.

**Reg. U. S. Pat. Off.*

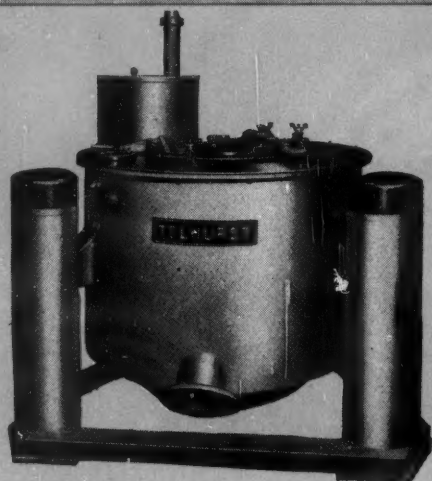
FOXBORO

REG. U. S. PAT. OFF.

liquid s

SEPARATION S

A TEAM OF SPECIALIZED MEN AND MACHINES OFFER
ECONOMICAL SOLUTION TO YOUR SPECIFIC LIQUID



Tolhurst®

CENTRIFUGALS

BATCH-O-MATIC®

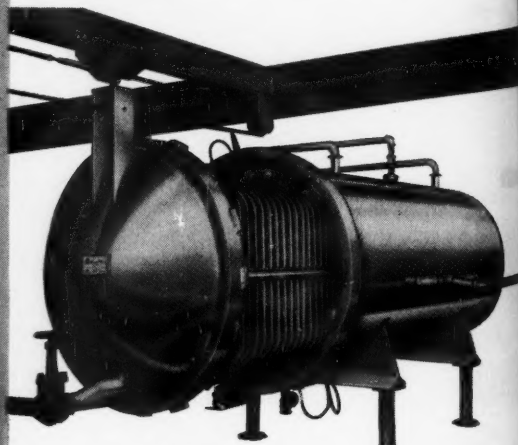
BATCH-MASTER®

SUSPENDED

CENTER-SLUNG®

MAXI-FLEX®

CONTINUOUS



Niagara®

PRESSURE FILTERS

VERTICAL LEAF MODELS

in both horizontal and vertical tank designs, either fully automated stations or single filters.

BATCH-MISER®

horizontal plate models for polish filtration and batch operations

COMPLETE LABORATORY TE

Divisions of American Machine and Metals, Inc.

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MATIC DEVICES • LAMB ELECTRIC COMPANY • HUNTER SPRING COMPANY • GLASER-STEERS CORPORATION

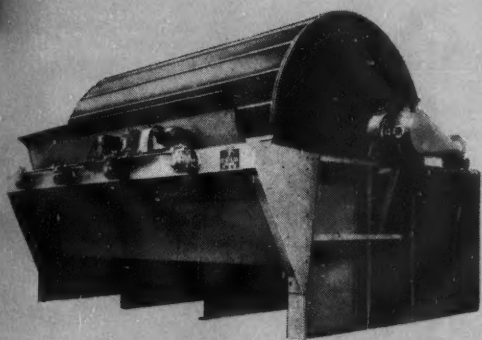
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LIQUID-SOLIDS SEPARATION PROBLEM

specialists in

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by Centrifugal Extrac-
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and Continuous Vacuum
or Pressure Filtration •
Filter Media



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**CONTINUOUS FILTERS
CUSTOM ENGINEERED**

VACUUM OR PRESSURE

ROTARY DRUM

Scraper, Precoat, String, Roller
and Cloth Belt Cake Removal

HORIZONTAL TABLE

DISC



FEON®

**NATURAL AND MAN-MADE
FILTER MEDIA**

FEON manufactures correctly designed

- Anode bags and diaphragms
- Centrifugal liners
- Dust tubes
- Plate and frame filter covers
- Pressure leaf discs
- Pressure leaf sacks
- Vacuum disc sector bags
- Vacuum drum covers, belts, blankets
- Yardage produced or slit to width

TESTING FACILITIES AVAILABLE

WRITE FOR LITERATURE. PLEASE SPECIFY: TOLHURST . . . NIAGARA . . . FEINC . . . FEON

DIVISIONS OF

American Machine and Metals, Inc.
EAST MOLINE, ILLINOIS

View the latest in G-E Process-Instrumentation at the National Chemical Show, International Amphitheater, Chicago, Booth 224, Sept. 5-8 and . . . ISA Conference & Exhibit, Los Angeles Memorial Sports Arena, Booth 702, Sept. 11-15.

PROBLEM: how to collect, record and transmit critical fluid flow data more accurately than ever before.

SOLUTION: custom-designed flow measurement systems from General Electric.

RESULT: reliable process control, simplified fluid accounting, precision batch blending and loading.

System instrumentation includes: true mass flowmeter, available in 13 standard ranges ■ null balance recorders, a full line of strip and round-chart ■ new telemetering equipment, analog and digital.

In addition, ticket printers and totalizing counters are available for visual digital display and pre-set counters may be added to provide precision control in blending and loading operations.

FOR FLUID FLOW PROCESS:

In a variety of system applications, these General Electric instruments cut operating costs and boost plant production . . . through *simplified* and *more accurate* measurement. No wonder they've been specified by process engineers throughout the world. *Performance-proved . . . on the line!*

For complete information, contact your nearby General Electric sales office or write Section 599-08, General Electric Co., Schenectady 5, N. Y. for the following bulletins: GEA-6925, Mass Flowmeter; GEA-6887, Null Balance Recorders; GEA-7163, Telemetering Systems. In Canada, contact Canadian G.E. Co. Ltd., 940 Lansdowne Ave., Toronto 4, Ontario. Outside the U.S. and Canada, contact International G.E. Co., 150 E. 42nd St., New York 14, N. Y.

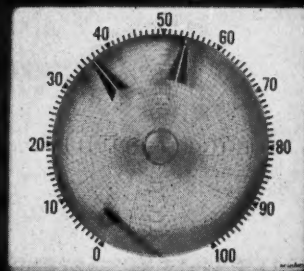
INSTRUMENT DEPARTMENT

GENERAL  ELECTRIC

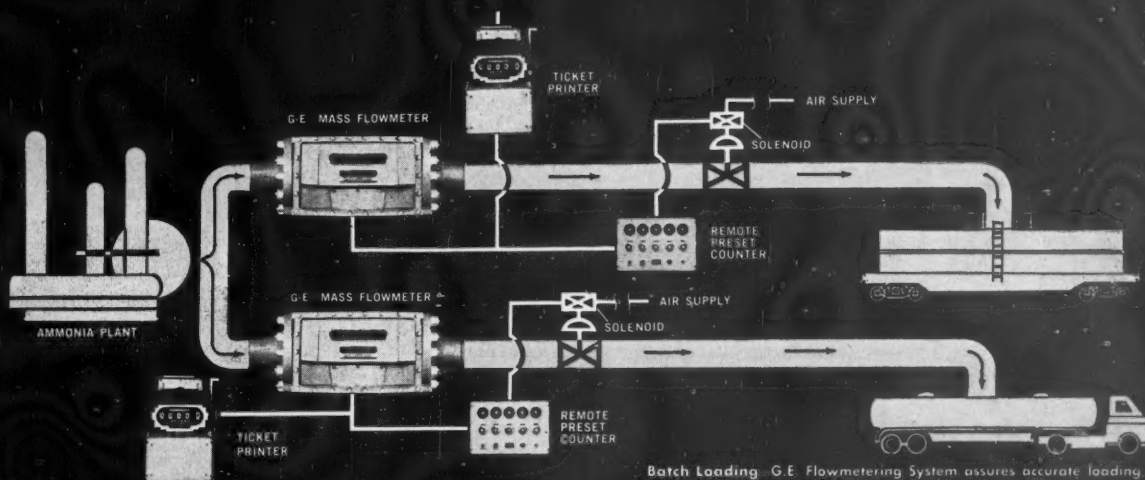


Mass Flowmeter measures fluid flow directly in pounds, eliminates volume-to-mass conversion. $\pm 1\%$ accuracy unaffected by change in pressure, density, temperature, viscosity, flow rate. 13 standard ranges now available.

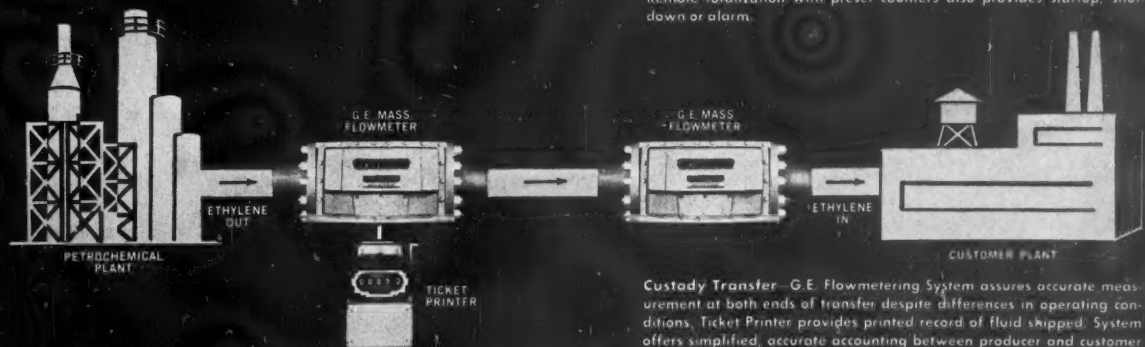
HIGH ACCURACY



General Electric Null Balance Recorders feature: silicon diode reference voltage source for operational reliability; varied control forms for versatile applications; components mounted on swing-out panel to simplify routine maintenance. Full line includes multipoint, single and two-pen—strip or round-chart models.

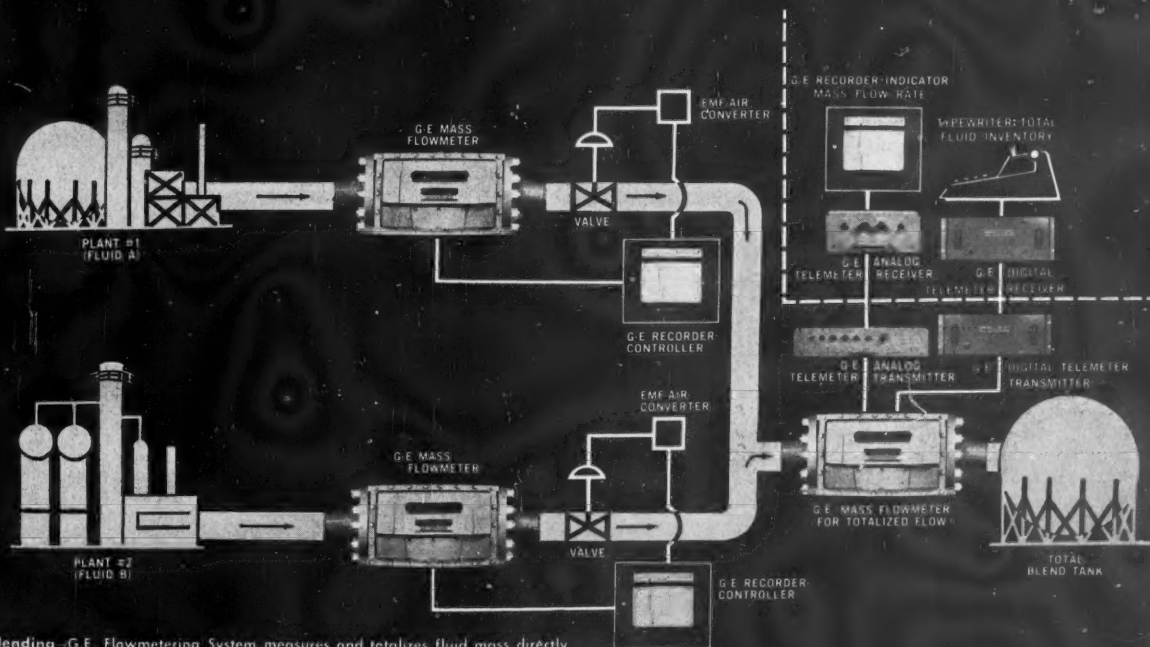


Batch Loading—G.E. Flowmetering System assures accurate loading, precise totalization, is unaffected by temperature changes in tank or pipe. Meter measures different fluids with no calibration change. Remote totalization with preset counters also provides startup, shut-down or alarm.



Custody Transfer—G.E. Flowmetering System assures accurate measurement at both ends of transfer despite differences in operating conditions. Ticket Printer provides printed record of fluid shipped. System offers simplified, accurate accounting between producer and customer plants and also in interplant transfers.

MEASUREMENT SYSTEMS FROM GENERAL ELECTRIC



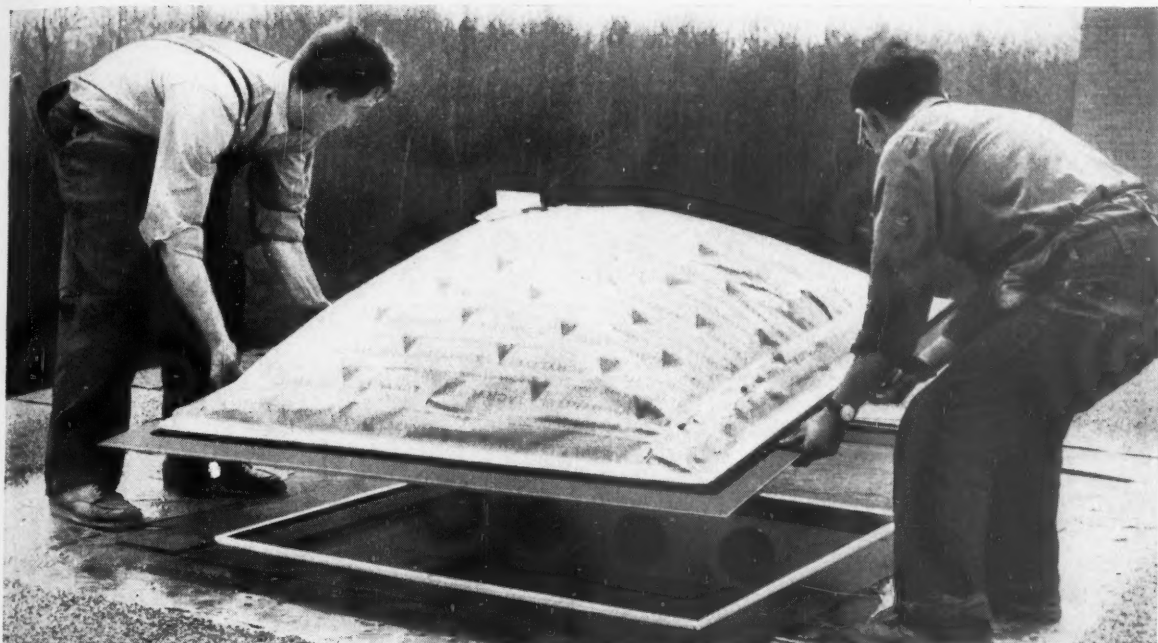
Fluid Blending—G.E. Flowmetering System measures and totalizes fluid mass directly, eliminates laborious volume-to-mass conversions. Predetermining counters assure simplicity and accuracy in blending operations. Data is instantly telemetered to central locations by new G-E Telemetering. Typical blends are refrigerants, solvents and special naphthas.

CYANAMID

Chemical Newsfront



EASIER TO SEE, EASIER TO SELL! From beer to bandages, packaging treated with CALCOFLUOR® WHITE brightener stands out on shelf or counter, boosts impulse sales. This remarkable product absorbs invisible UV-rays from fluorescent lighting, re-emits it as additional eye-catching brilliance. Grocery bag above is fortified with Cyanamid's Melostrength® resin. Use coupon for added information. (Dyes Department)



PACKAGED DAYLIGHT. These men are installing the new, all-acrylic Wasco Twin Dome made by Cyanamid. Twin Dome is a completely sealed, insulated, shatterproof, low-profile skylight with inner and outer domes available in any combination—clear, colorless, white translucent or reflective—to allow maximum control of light levels and heat gain. The domes are bonded to an aluminum nailing flange for easy installation and have an inch of “dead air” between them for exceptionally efficient insulation against heat and cold.

(Wasco Products Department)

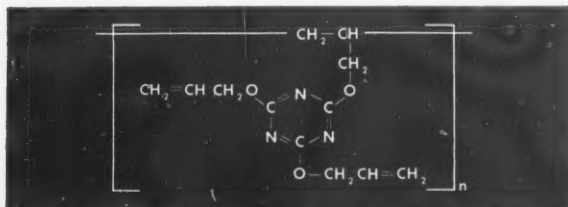


VINYL CONVERTIBLE WINDOWS stay transparent and flexible when the formulation includes CYASORB® UV light absorbers. Cyasorb causes vinyl windows to resist discoloration and cracking under the sun's damaging ultra-violet rays. It also retards the yellowing of the inner plastic layers in safety glass. Secondary benefits here may be better vision and the protection of the decorative color in the car's upholstery.

(Intermediates Department)

CYANAMID

AMERICAN CYANAMID COMPANY
30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.



A NEW APPROACH TO AN OLD PROBLEM. Pre-polymerization of triallyl cyanurate (TAC) should provide more effective use of this polyfunctional monomer through concentration of reactivity in large molecules and decrease of volatility.

Our data on preparation of TAC pre-polymers and pre-copolymers with vinyl monomers should be helpful in research directed toward upgrading vinyl systems by increasing heat resistance and decreasing flow, creep and tendency to stain. Write for technical literature.

(Market Development Department)

For further information on products in this advertisement wire, or mail this coupon to:

CE-81

AMERICAN CYANAMID COMPANY
30 Rockefeller Plaza, New York 20, N. Y.
Dept. 6365

Please send me additional information on

- ☐ CALCOFLUOR WHITE Brightener
- ☐ WASCO TWIN DOME Skylights
- ☐ CYASORB UV Light Absorbers
- ☐ TRIALLYL CYANURATE (TAC)

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Company _____

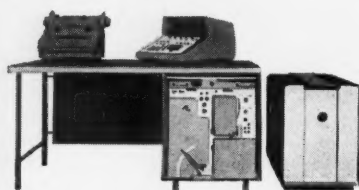
Position or title _____

Address _____

City _____ Zone _____ State _____

ANOTHER IN THE CAUTIONARY SERIES ABOUT RECOMP II [in which we reveal nearly all the computer's subtle enticements]

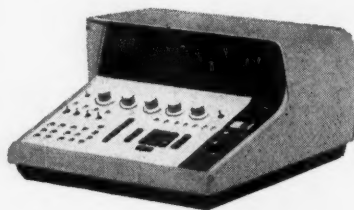
Here, for the very first time, is an unpurged listing of the allurements of Recomp II. They are potent. They are persuasive. They are enticing. Indeed, in reading them it would be wise to exercise a decent restraint... for you may find yourself falling in love with a computer:



- 1] The first solid-state digital computer on the market was Recomp II. The finest computer on the market is still Recomp II. Recomp II's dedicated engineers are determined that the situation shall remain this way; they have an obsessive regard for this precise machine they have so carefully developed.
- 2] Recomp II is the only compact computer with built-in floating point arithmetic. It defies being hemmed in on a problem. With its large capacity it obviates computer-claustrophobia.
- 3] Always the darling of the medium-scale computer user, Recomp II has been so well accepted that it can now be offered at a *significantly lower price*. It still provides the identical quality, solid-state performance, and features that can't be found on computers costing three times what Recomp II used to cost.
- 4] Recomp's memory, employing the new optional Recomp Magnetic Tape Transport units, would stagger an elephant. Each unit has a memory of over 600,000 words. Up to eight of these transport units can be connected to Recomp II, giving you a computer with a total memory capacity of over 5,000,000 words. Remarkable!
- 5] The speed of the new magnetic tape

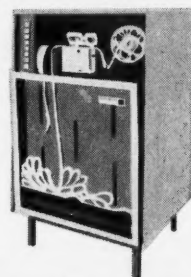
control described above is quite remarkable, too. Read and write speed is 1850 characters a second; bidirectional search speed is 55 inches per second.

- 6] Always the darling of the medium-scale computer user, Recomp II has been so well accepted that it can now be offered at a *significantly lower price*. It still provides the identical quality, solid state performance, etc.
- 7] Recomp II seems to have more built-in features than a dream-home kitchen. It has built-in square root command. Built-in automatic conversion from decimal to binary.
- 8] Would you say that a RUG is important to a computer? Well, it is. The RUG we mean is Recomp Users Group. This is a highly active group, sharing up-to-date information, and keeping in close contact by monthly bulletins. A consideration not to be overlooked when buying a computer.
- 9] Always the darling of the medium-scale computer user, Recomp II has been so well accepted that it can now be offered at a *significantly lower price*. It still provides, etc., etc.



- 10] Recomp's keyboard, which you can see above, looks easy to operate. It is. And because it requires no specialized talents, anyone with computer problems can be taught to use Recomp II. Quite a handy machine to have around.
- 11] Recomp II can easily be installed anywhere, requiring no more electricity than an ordinary electric toaster.
- 12] Another new optional feature for

your Recomp II is the Facitape tape punch and reader console, shown below. It punches 150 characters a second, reads 600 characters a second, and stops on a character. It adjusts to read and punch from 5 through 8 channels. Quite uncanny.



- 13] A visual readout on the control panel allows you to check any information about to be entered into Recomp II before you press the "enter" button. The information can be corrected easily if necessary. This is further evidence of Recomp II's staunch adherence to efficiency.
- 14] Recomp II's programming is highly efficient. It has 49 basic instructions, expandable to 72. Word length is 40 binary bits; very large, indeed.
- 15] Always the darling of the medium-scale computer user, etc., etc., etc.
- 16] Recomp II has a large sub-routine and program library, and a large program exchange.
- 17] Each word programmed into Recomp II contains two instructions.

Recomp II has many other features, but as you can see, space is running short. We would have liked to have lingered upon the details of Recomp II's own full scale compiler called SALT, and even maybe discuss the high-speed loops a little... but. Perhaps, if you are beginning to feel the stirrings of your acquisitive instinct toward Recomp II, you should see it in action. We can arrange a demonstration for you through our local offices in New York, Chicago, Boston, San Francisco, and Long Beach. Or, at the very least write for more information. We have some nice brochures you will enjoy reading.

Write AUTONETICS INDUSTRIAL PRODUCTS, Dept. 086, 3400 E. 70th St., Long Beach, Calif. The Autonetics Division of



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*even on the
tank car...*

with
**CONTINENTAL-
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GEAR-DRIVEN
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ADDED SAFETY is an important benefit when you equip your loading rack with the only gear-driven swivel joint on the market. No danger of the operator slipping on wet or icy decking while pulling down a loading arm. No chance of arm dropping or rising unexpectedly to spill hot or caustic products. No counterbalance arms, cables or pulleys to endanger clearance on the platform. The entire loading operation is constantly controlled by this easy-to-crank joint.

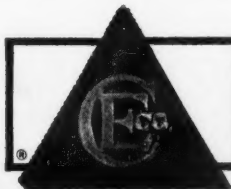
TROUBLE-FREE SERVICE offers an equally important advantage. This gear-driven swivel joint incorporates all the proven features of C-E's

popular US-Type Joint. It breaks like a union for quick, easy repairs on location without special tools. No need to disturb bearings when repacking. Wide-spaced bearings and non-split races last longer and permit greater foot/pound loading. Separate races can be reversed easily to double their life.

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GAS AND LIQUID?**

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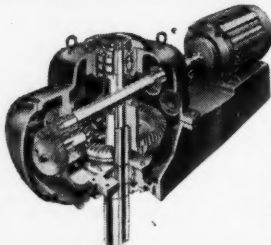
It takes mixing know-how to handle high rate gas/liquid contacting. You may need multi-speed motors to combine the right torque during gassing with overload protection at no gas flow. Philadelphia engineers can tell you for sure.

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ASK ANY ENGINEER / GEARS ARE THE HEART OF A MIXER

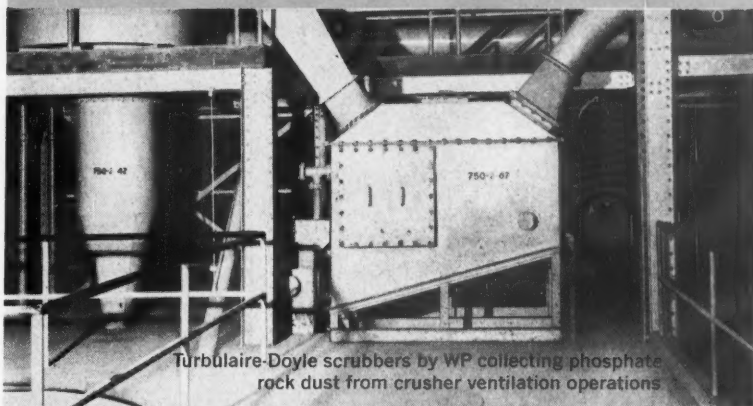


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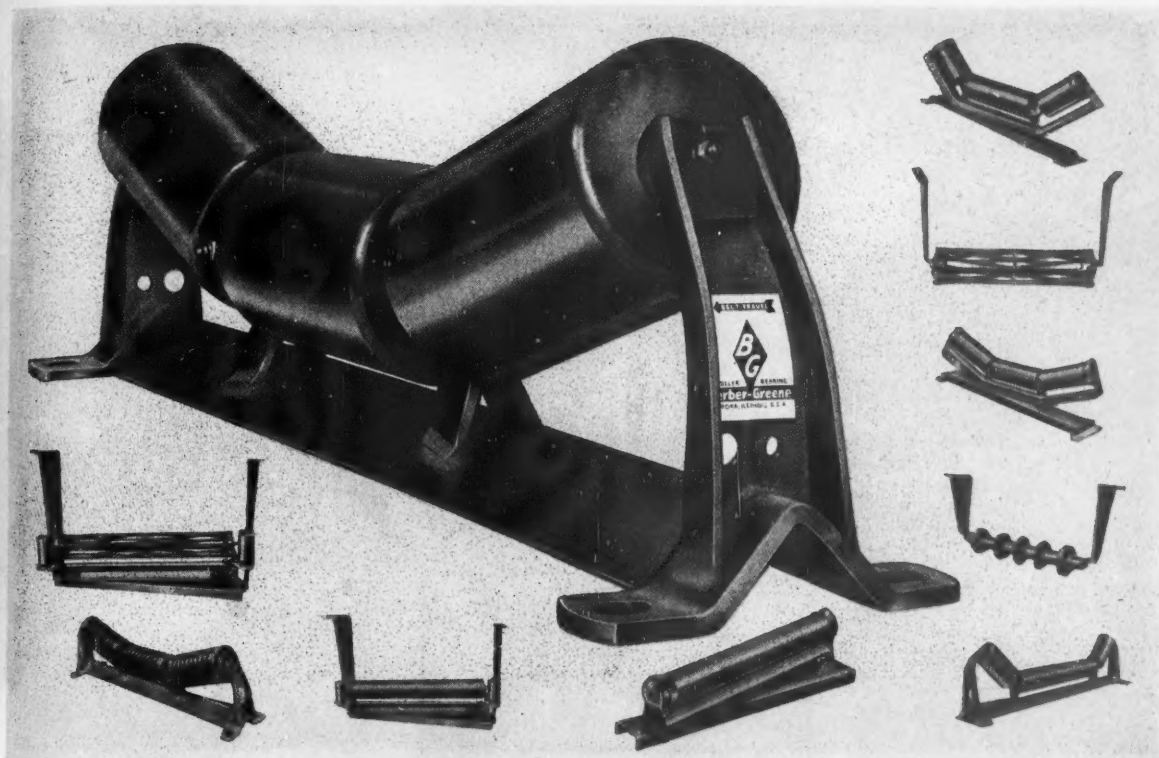
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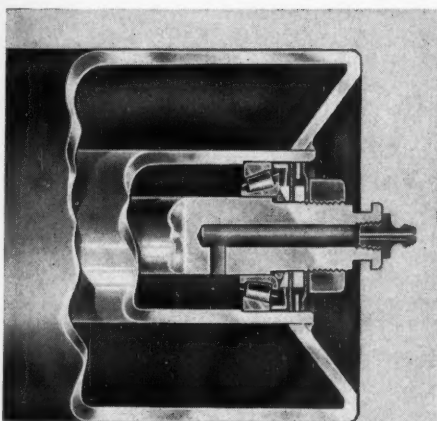
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broadest line of quality idlers at lowest price



HEAVY-DUTY IDLER FEATURES: exclusive combination nylon-and-metal face and labyrinth seal; tapered roller bearings; exclusive neoprene rubber "O" ring; material-shedding recessed roll ends; large capacity grease reservoir; and fittings that provide direct lubrication of each roll.

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- Broadest line—more than 800 different types and styles in four complete series, offering an idler exactly right for your conveyors.
- Larger bearings give longer service under most adverse conditions.
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- End cups 100% welded to roll shell forming sealed, rugged, extra-duty roll.
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CHEMICAL ENGINEERING—August 21, 1961

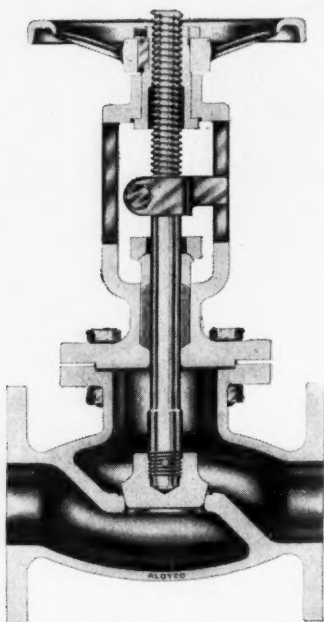


Fig. 311-B

Do you know the advantages of the new Aloyco Globe Valve design?

The design of 150 lb. globe valves of sizes 2" and larger features a non-rotating stem, non-rising handwheel with disc assembly pinned to the stem. This is accomplished by rotating the handwheel and yoke bushing assembly and preventing stem rotating by adding a stem key which fits into the bonnet yoke. The major advantages of the new design result in:

- No spiral wear pattern on stem from hardened packing or hard deposit in stuffing box.

- Rapid visual check of throttling control by observing location of stem stop.

- No galling of back seat because of rotating stem.

- No galling between seat and disc.

- Stronger disc to stem connection.

- No spinning of disc.

- Less corrosion attack because of elimination of cavity between stem and disc.

These new design advantages are available in stainless steel and corrosion

resistant alloys in sizes 2" and up. For full information write for Bulletin #7, Alloy Steel Products Company, Inc., 1301 West Elizabeth Avenue, Linden, New Jersey.

Q.11



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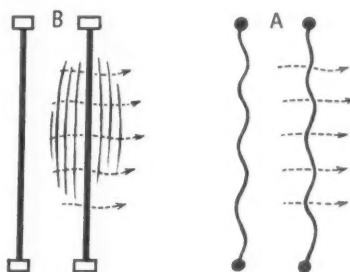
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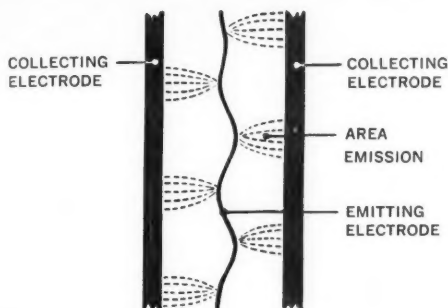


SUPERIOR PRECIPITATOR PERFORMANCE

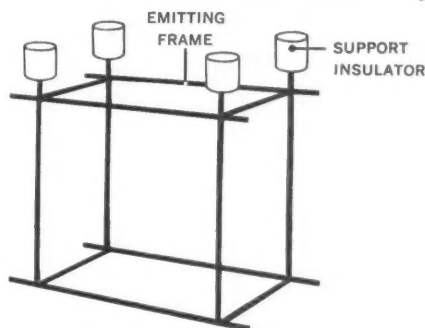
—how it's
helped by Buell's
exclusive
emitting system



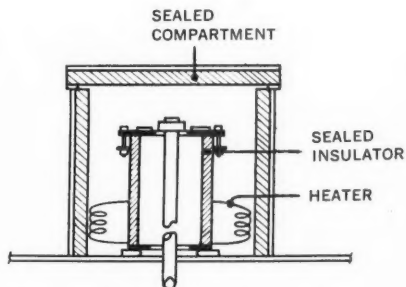
LESS THAN 2% REPLACEMENT — Each stainless steel Buell Spiralectrode is firmly fixed top and bottom to a rigid frame (A). Self-tensioned in this way, the electrode does not sway or lose alignment as shown at (B), even under current surges or varying gas flows. Buell's 10-year replacement record in this critical area is under 2%.



HIGHEST EMISSION — TOP EFFICIENCY — The patented spiral shape of emitting electrodes in the Buell precipitator presents collectors with areas of maximum emission per unit of power input. Because there is no problem of efficiency-destroying misalignment here, you can apply maximum voltage to achieve peak emission.



RUGGED SUSPENSION — Buell SF Electric Precipitators are designed and built to take extremely rugged operating conditions. The emitting frame is constructed of heavy-gauge steel and the whole unit is held rigid by four supporting insulators. Because of this rigid box-type construction, misalignment or arcing is not a problem.

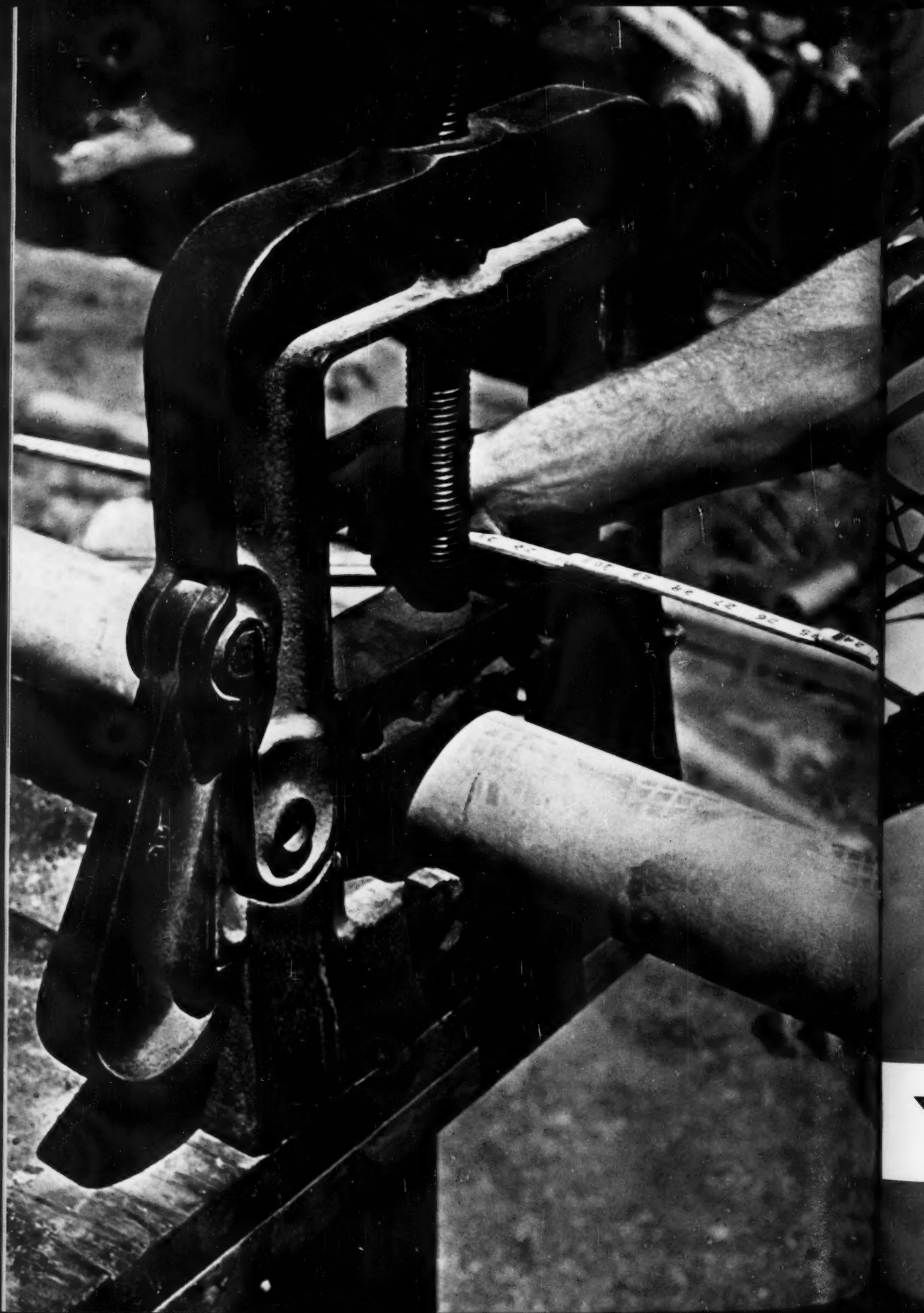


QUARTZ INSULATORS — SEALED COMPARTMENTS — Special temperature- and shock-resistant quartz insulators are sealed in individual compartments. This prevents circulation of dirty gas from the precipitator, without the need for costly ventilating systems. Thermostatically controlled heaters prevent condensation during start-up.

... and don't forget the simple, effective, mechanical rapping system, possible only because rugged Buell construction permits electrodes to be so rigidly mounted. Other features: Buell's advanced collecting electrode design... adjustable baffles. No wonder you're sure to be pleased with Buell's superior performance, minimum maintenance! **Buell Engineering Co., Inc., Department G, 123 William Street, New York 38, New York.** Electric Precipitators • Cyclones • Bag Collectors • Combination Systems • Classifiers • Fans. Member Industrial Gas Cleaning Institute

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Glas-Col Apparatus Company

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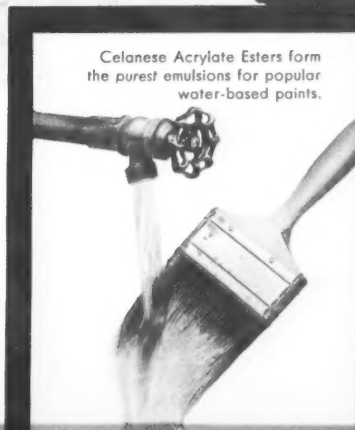
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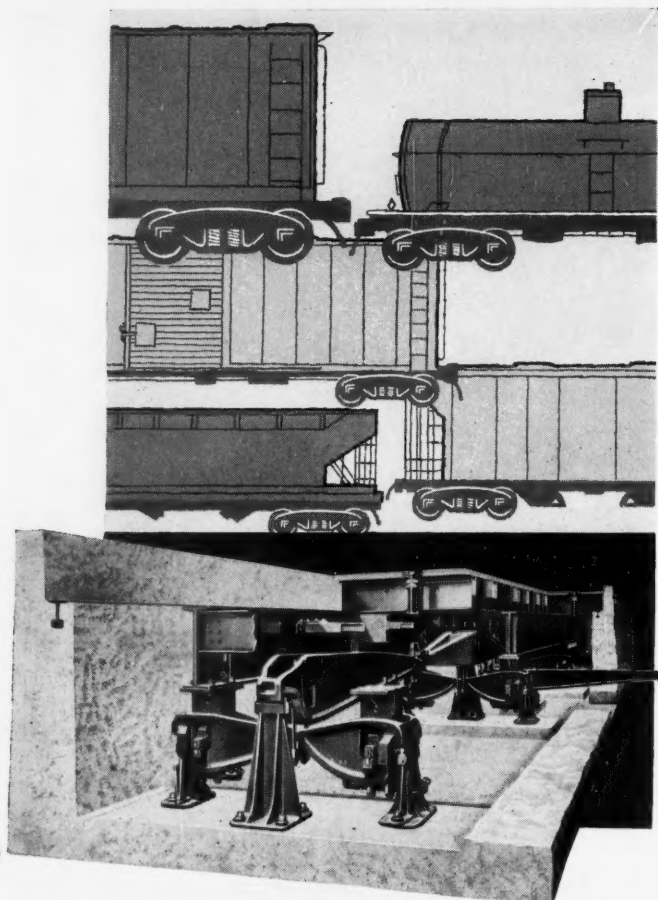
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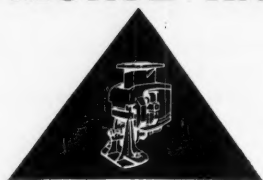
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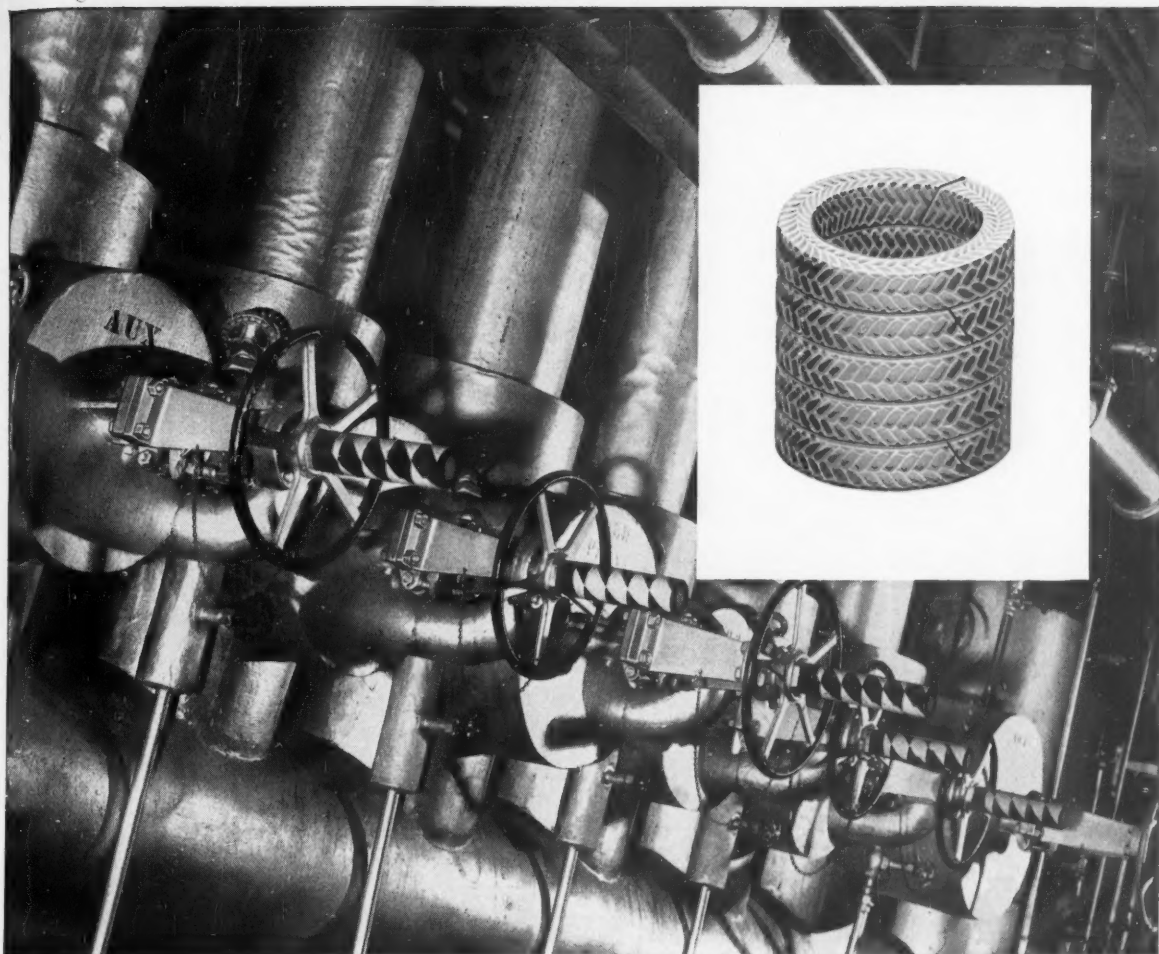
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The packings: asbestos impregnated with a Du Pont TEFLON TFE-fluorocarbon resin. The application: main distribution control valves on the boiler header shown above, handling steam at 150 psi and 356°F. The performance advantages: the packings do not leak . . . do not need retightening . . . last indefinitely . . . valves turn easily without "persuaders". Unlike oil, grease and graphite additives, which squeeze out and leave a dry, abrasive base, the impregnations of TEFLON make a lasting mechanical bond with the asbestos. The cost savings: average savings per valve of \$10 per year on repacking and retightening formerly necessary, and \$30 per year formerly lost through leaking steam—a total saving of \$280 per year for the 7 steam valves.

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packing materials. TEFLON resins are inert to virtually all chemicals and solvents, over a temperature range from -450°F. to 500°F. Their low-friction characteristics reduce wear on cylinders and shafts.

These facts have been put to the hard test of dollars-and-cents cost accounting in many hundreds of applications. In addition to reduced costs of packing maintenance and replacement, the use of TEFLON permits standardization, cuts down inventories of many different types of packing. Consult your supplier about the many varieties of constructions available in packings made with TEFLON, and write for new booklets: "Packings for Valves and Pumps", and "Designing with TEFLON". Address: E. I. du Pont de Nemours & Co. (Inc.), Dept. CE-821, Room 2507T Nemours Building, Wilmington 98, Delaware.

In Canada: Du Pont of Canada Limited, P. O. Box 660, Montreal, Quebec.



TEFLON®
FLUOROCARBON RESINS

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

TEFLON is Du Pont's registered trademark for its family of fluorocarbon resins, including TFE (tetrafluoroethylene) resins and FEP (fluorinated ethylene propylene) resins.

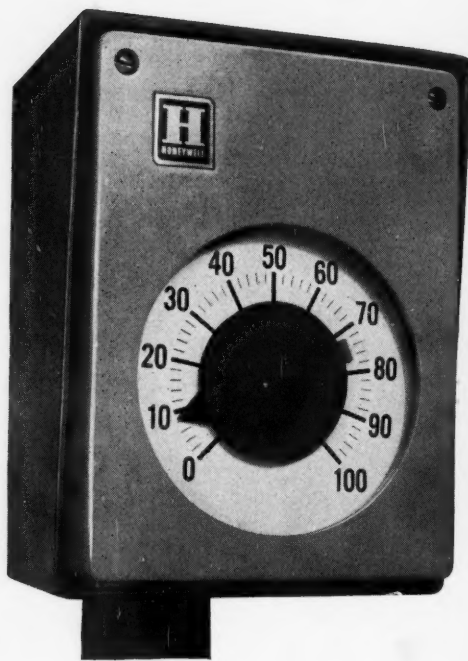
NEW HONEYWELL TRANSMITTERS



New pneumatic bellows flow transmitter

gives all the economy and convenience of pneumatic transmission and all the efficiency of the bellows meter body with the added option of field indication. The transmitter has 16 ranges (0-10 to 0-400 inches of water) and is used to transmit flow or liquid level measurements in open or closed tanks.

Transmitter Features: Make range changes in the field simply by replacing a single spring assembly. You can adjust damping quickly and accurately while the instrument is in operation. You can install meter with vertical or horizontal piping, so that it vents, drains and purges itself.



New pneumatic temperature transmitter

offers thermal system options with ranges from -125° to 1000°F . Completely new, completely flexible, this transmitter gives you a choice of either mercury or gas actuated thermal system with a wide selection of measuring bulb styles.

Transmitter Features: Mount transmitter on a pipe welded to flow line or on a bracket that clamps to hex head of socket. Vibration resistant thermal system means accurate measurement on vibrating flow lines.

Added Features of both transmitters are: automatic ambient temperature compensation; two-way overload protection (100% of span on temperature transmitters, 100% of rated meter body pressure on bellows flow transmitters); modular construction for simplified maintenance; self-locking feature to prevent upset; die-cast aluminum case $4'' \times 7'' \times 9''$; available with concentric scale or as non-indicator; transmission accuracy $\pm 0.5\%$ full scale; accuracy of indication $\pm 1\%$ full scale.

For more complete details on the new temperature and bellows flow transmitters, call your nearby Honeywell field engineer. Or write MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa. In Canada, Honeywell Controls, Ltd., Toronto 17, Ontario.

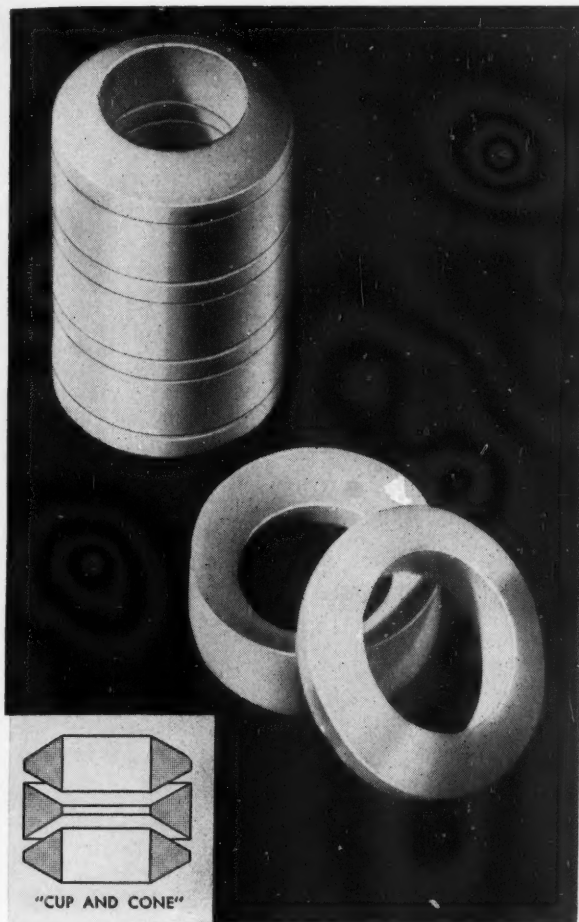
Honeywell



First in Control

SINCE 1885

HONEYWELL INTERNATIONAL Sales and Service offices in all principal cities of the world. Manufacturing in United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.



try New CHEMPRO "cup & cone" and "wedge" TFE Teflon[†] packing sets

*The New Resilient, Low Gland Pressure Packings for Valves,
Heat Exchangers or Other Static or Semi-Static Applications*

Chempro Style No. 300 "Cup & Cone" and Style No. 305 "Wedge" packing ring sets make tight, secure seals under minimum gland pressure. A nominal force applied to the gland causes the rings to slide against each other, exerting pressure both against the stem or

rod, and against the bore of the stuffing box. These two popular styles are being used with great success in a wide range of static and semi-static packing applications where rotation is not a factor.

COMBINATION PACKING SETS FOR ROTATING EQUIPMENT OPERATING ON CORROSIVE AND ABRASIVE SERVICES

By the proper combination of resilient, sensitive Chempro "Cup & Cone" or "Wedge" rings with tough, pressure-resisting Chempro Style No. 101 packing rings (the original TFE Teflon packing),

combination sets have been made up giving months of extra service life to a wide range of rotating and reciprocating type equipment operating under extremely corrosive or abrasive conditions.



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The Original Fabricators of Teflon Packings and Gaskets

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No. CP-552 giving the complete story
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[†] DuPont trademark

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can you use computer control *profitably*?



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Where and how?

The answer often lies in intermediate stages of improvement in sensing, measuring, controlling, computing.

Bailey engineers can help you determine and prove—one step at a time—how far analog or digital systems can be profitably applied in your operations. Bailey is equipped, by broad experience, to provide single-source responsibility from sensing and measuring instrumentation to complete automation. *Bailey 700 Systems* are installed, in operation, or on order, at locations from coast to coast and throughout the world.

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Centralize and simplify information display—use analog and digital techniques to clarify information, aid operator understanding, improve reliability of interpretation, and save space.

Extend use of interlocks and limiting circuitry—use digital solid-state components to extend supervisory controls, thereby minimizing effects of human error.

Increase use of automatic sub-loops—simplify and standardize the starting, controlling, and stopping of major plant components and sub-systems.

Extend on-line controls—integrate sub-loops, interlocks, and limiting controls with conventional controls to secure automatic operation over full range, once unit is on the line.

Provide performance monitoring—add computing facilities to provide significant up-to-date calculations for operation improvement and maintenance scheduling.

Integrate all system elements—add start-stop control to provide full automation, the ultimate goal.

P 158-1

PULP AND PAPER DIVISION
BAILEY METER COMPANY
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In Canada—Bailey Meter Company Limited, Montreal





In a laboratory test, samples of Garlock 5881 packing were immersed in a 25% nitric-75% sulfuric acid mixture at room temperature. After 8 minutes agitation the samples caused the acid solution temperature to increase but 1.5°F... indicating only slight reaction. Increases up to 5°F are considered acceptable for nitric acid service.



ENGINEERED TEFLON PACKINGS for Chemical Processing

Now . . . another Garlock exclusive! A low-cost blue asbestos packing that resists **STRONG** acids at temperatures from -90°F to +500°F. It's new Garlock 5881 LATTICE BRAID† . . . laboratory tested and proved to be non-nitrating. A completely new Garlock manufacturing technique combines the blue asbestos with over 30% sintered Teflon* (by actual weight); this adds greater stability under temperature changes and outstanding resistance to glazing. Garlock 5881 LATTICE BRAID** is non-absorbent, with no "wicking"; hence it has minimum swell. Countless bearing points of Teflon powder reduce friction and wear. Retightening or adjustments are rarely, if ever necessary.

Yours at the price of regular packing. Garlock 5881 LATTICE BRAID Packing sells for almost 40% less than other blue asbestos Teflon Packings. Yet, you enjoy all the above features *plus* the advantages of exclusive LATTICE BRAID construction—com-

pletely integrated structure for greater strength, longer life, more flexibility and lower maintenance cost. No single outer braid or cover to wear through. Holds together without disintegrating, wears far beyond ordinary packings.

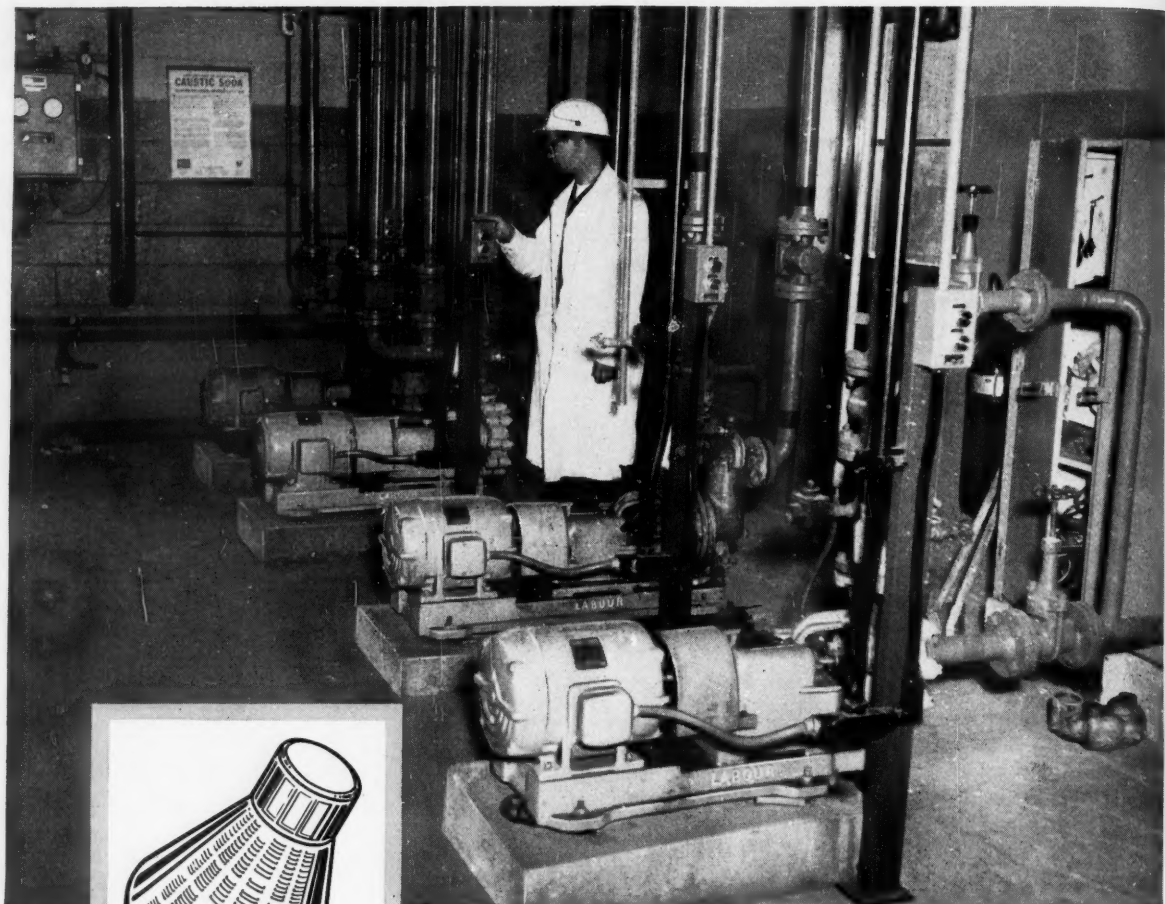
Fast warehouse delivery. Garlock 5881 LATTICE BRAID Packing is immediately available in sizes from 1/4" through 1" in either spool or reel form. Call your Garlock representative at the nearest of 26 Garlock sales offices and warehouses throughout the U.S. and Canada. Or, write for Catalog AD-185, Garlock Inc., Palmyra, N.Y.

Canadian Div.: Garlock of Canada Ltd. **Plastics Div.:** United States Gasket Company. **Order from the complete line** of quality Garlock products . . . Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Stock and Parts.

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GARLOCK



LaBour Pumps at Brush Beryllium Help to Put a Man into Space

When Commander Shepard made his historic flight to the edge of space he was protected from the intense heat of re-entry by a solid shield of beryllium, the light weight, heat resistant metal produced and fabricated by Brush Beryllium Company at Elmore, Ohio. The refining of this unusual metal is a complicated chemical process, and Brush Beryllium depends on LaBour pumps throughout for handling corrosive liquids of various kinds.

Some of the LaBour Pumps at Elmore have been operating for ten years. Many more are

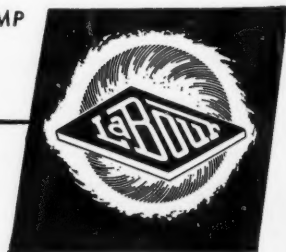
past four years of service, and all are on an around-the-clock, seven-day-week basis. Little or no service troubles have been encountered, which explains why the twelve new pumps recently installed in an expansion move are also LaBours.

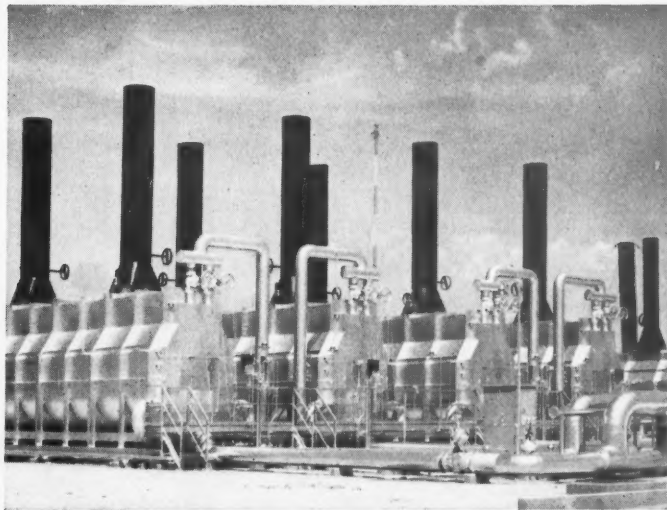
Perhaps *your* liquid moving problem isn't as glamorous — or as difficult — as that at Brush Beryllium Co. Maybe it's even more so. Either way, it will pay you to investigate how you can save money and headaches by specifying LaBour pumps to do your toughest jobs.

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100,000 to 200,000,000 BTU

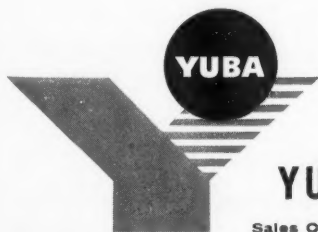
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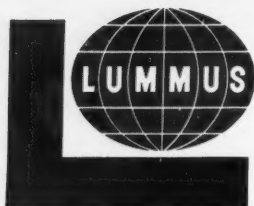
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ENGINEERS AND CONSTRUCTORS FOR INDUSTRY

New Shawinigan process lowers production cost of hydrogen cyanide

A new hydrogen cyanide process, developed by Shawinigan Chemicals Ltd. of Canada and available through The Lummus Company, produces HCN from ammonia and hydrocarbon (methane or propane) in a non-catalytic, oxygen-free reaction. The process — first commercial application of the "FLUOHMIC"® reactor — offers low production costs and ease of operation.

Yields on hydrocarbon and ammonia exceed 85% with negligible undecomposed ammonia carry-through, simplifying recovery or disposal requirements. Furthermore, valuable high-purity hydrogen by-product is available for use as required.

The Shawinigan HCN process produces hydrogen cyanide competitively using 8 mill power and 25-30¢ per MSCF natural gas. It becomes increasingly attractive in areas of lower power costs or higher cost hydrocarbon. A commercial scale reactor is being operated by Shawinigan Chemicals Ltd.

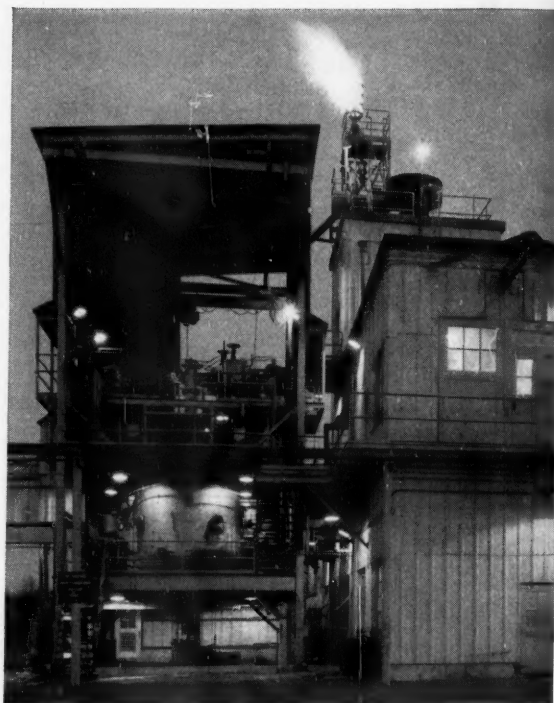
How the Process Works

The reaction system uses a uniquely designed fluidized bed reactor to realize the efficiencies of a very high temperature in the hydrogen cyanide reaction.

The Shawinigan HCN reactor consists of a refractory lined electrically heated vessel. It operates in the range of 2,400 to 3,000° F. at essentially atmospheric pressure. A non-consumed fluidized bed of coke particles is heated by electrical conduction. The reactor design achieves an extremely uniform high temperature throughout the reaction zone. At these very high temperatures the significant improvement in conversion rates — compared with conventional processing — results in a high concentration of product in the effluent gas. The effluent gas is cooled and purified by standard methods.

Process Advantages

Some major advantages of this process are: (1) Absence of water from the effluent gas. This eliminates the problem of tarry polymer formation in the cooling and recovery section. (2) Considerable reduction in unreacted ammonia in the effluent gas. This eliminates the problem of recovery or disposal of unreacted ammonia. A typical carry-through ammonia content would be 0.3 volume % on net reactor effluent. (3) Greatly reduced stringency in feed-stock purity requirements. This is a natural result of the elimination of catalysts



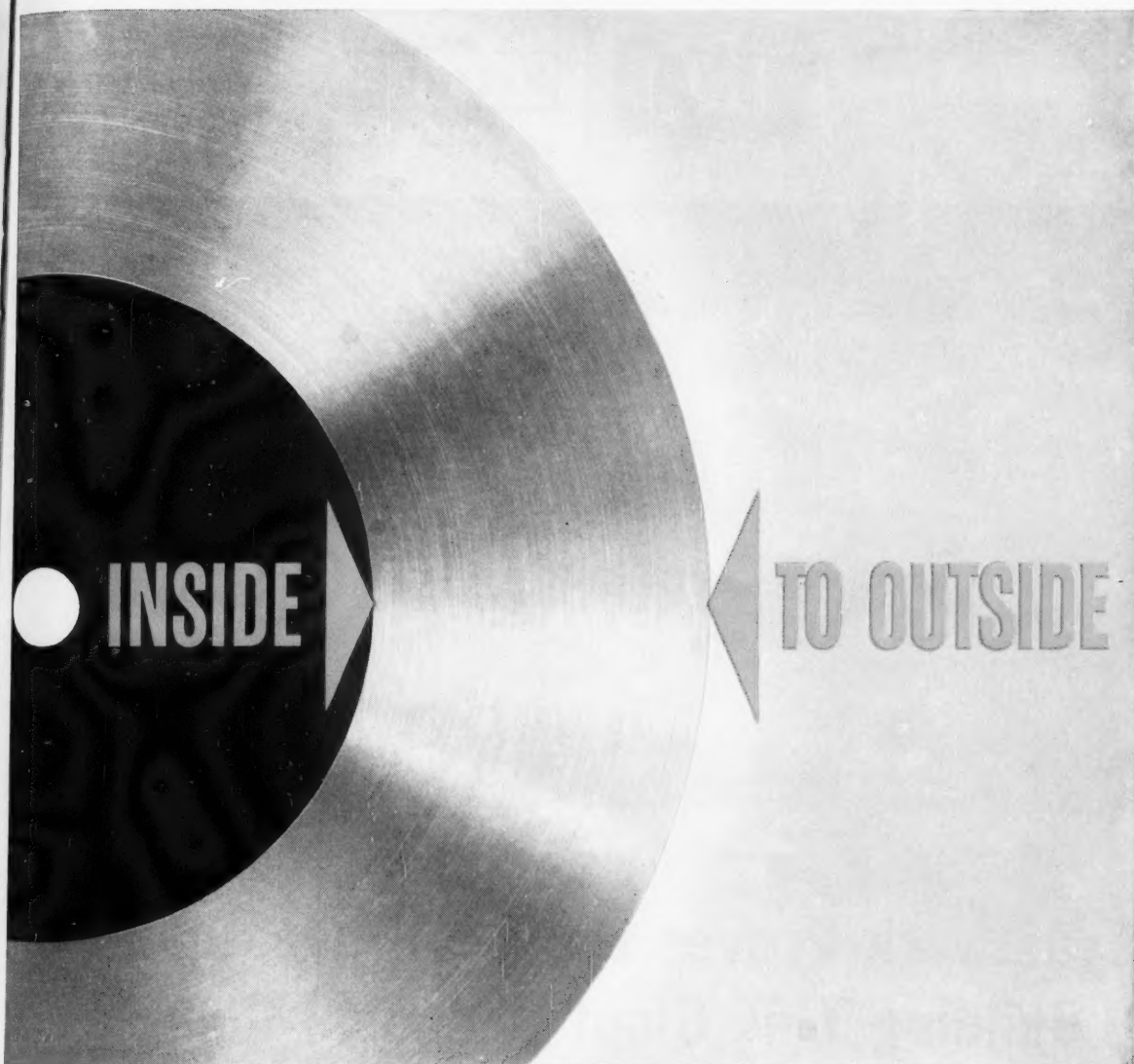
View of the Hydrogen Cyanide Reactor in operation at The Shawinigan Chemicals Limited Cyanide Plant.

from the process. (4) Flexibility in choice of hydrocarbon feed. L.P.G. can be used where natural gas supply is unavailable or interruptible. (5) Operating rates are flexible. Units will perform well at rates as low as 25% of capacity. (6) High concentration of HCN in the reactor effluent. This may be 5-6 times as high as in present commercial processes.

For further details on this process, contact your nearest Lummus office.

*Trademark — Shawinigan Chemicals Limited

THE LUMMUS COMPANY, 385 Madison Avenue, New York 17, New York, Houston, Washington, D. C., Montreal, London, Paris, The Hague, Madrid; Engineering Development Center: Newark, N. J.



maximum tube life per dollar—When you buy Timken® seamless steel pressure tubing, you receive fine forged quality that is uniform from heat to heat, tube to tube, order to order. We target it to your end use. And our metallurgists draw from a background of over 40 years' experience to help you select the one tube that will give you maximum tube life per dollar.

Timken seamless steel tubing is available in carbon, alloy and stainless grades, up to 11" O.D. and 3¼" wall. And there's a Timken seamless steel pressure tube to meet practically any combination of temperature, pressure or corrosion. For help that assures your selection of the one tube that will be most economical and perform best for you, call in Timken Company metallurgists. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable: "TIMROSCO". Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits.

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TIMKEN ALLOY STEEL AND SEAMLESS STEEL TUBING ARE AVAILABLE FROM STEEL SERVICE CENTERS IN 44 CITIES IN THE UNITED STATES



Toms River Chemical Corporation's manufacturing complex includes five plants, producing (1) vat dyes, (2) azo dyes, (3) epoxy resins, (4) anthraquinone, and (5) epichlorohydrin

Teamwork Proves the Best Investment in Building This Giant Chemical Complex

Shown above, as they look today, are the manufacturing facilities of Toms River Chemical Corporation* in New Jersey. Once a single vat dye plant, the project has grown into a multi-million-dollar complex of five plants—producing azo dyes, Araldite® epoxy resins, anthraquinone, and epichlorohydrin, as well as vat dyes.

The successful completion of this undertaking, like many others in various parts of the world, was largely the result of Kellogg and client working closely as a team. At Toms River, this teamwork started in 1955 when Kellogg was assigned full responsibility for a new anthraquinone plant, and continued until 1961—when the last of the four new plants went into operation. Throughout this long association, Kellogg functioned virtually as an arm

of Toms River Chemical Corporation in engineering, procurement, and construction. In these three areas, Kellogg and TRC specialists pooled their experience and technical know-how to execute best the capital investment for each plant.

Chemical companies interested in expanding their own manufacturing facilities are invited to write for the current 12-page Kelloggram which describes the Toms River chemical complex in detail.

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711 Third Ave., New York 17. A subsidiary of Pullman Incorporated

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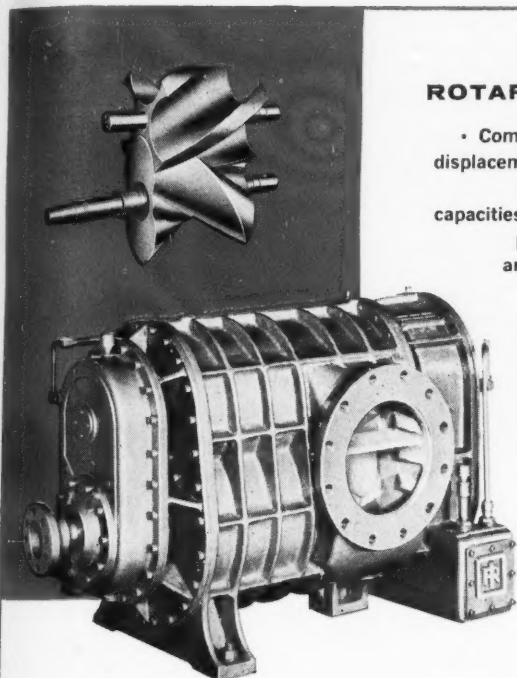


*Toms River Chemical Corporation's parent companies are CIBA Limited, J.R. Geigy, S.A., and Sandoz Ltd.

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ROTARY COMPRESSORS

- Compact, space-saving positive-displacement axial-flow Axi-compressors are now available for capacities from 100 cfm to 18,000 cfm, pressures to 250 psig and vacuums as required



Type L single-stage low-pressure units, with side suction and discharge, cover pressures to 15 psig or vacuums to 22" Hg, in capacities from 100 to 12,000 cfm. Two-stage units can be supplied for higher pressures and vacuums.



Type H high-pressure units, with bottom suction and top discharge, provide compression ratios up to 4.5 per stage and are designed for a maximum discharge pressure of 250 psig.



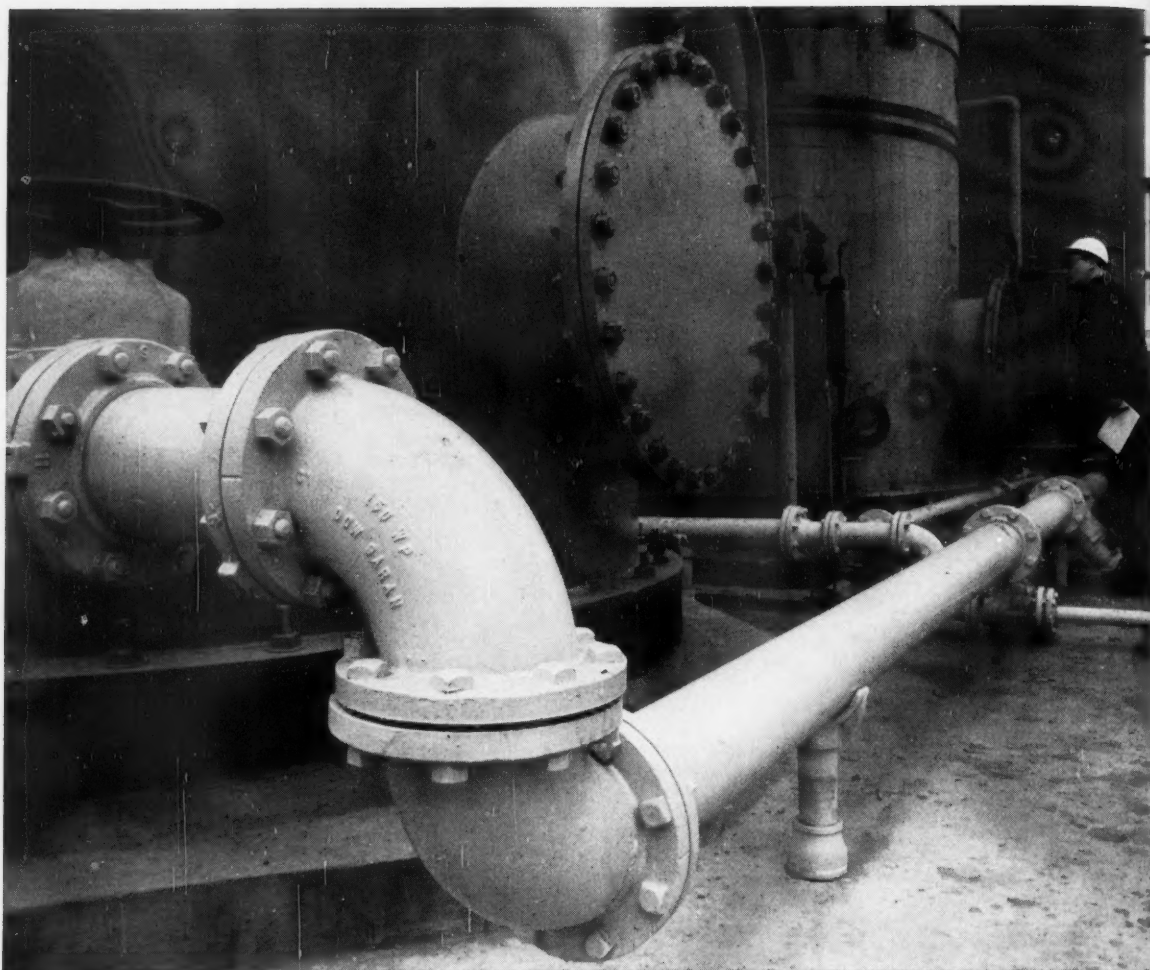
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THE WORLD'S MOST COMPREHENSIVE
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Now, with two Axi-compressor designs to choose from, you can meet a wider range of pressure and vacuum requirements than ever before.

Both types offer the time-tested Axi-compressor advantages of small size, light weight, high efficiency, oil-free compression, freedom from pulsations or vibration and exceptionally low maintenance. The two meshing helical rotors are the only moving parts. They do not touch each other or the casing — hence there is no metal-to-metal contact, no lubrication is required in the compression chamber, and rotors are not subject to mechanical wear.

Ask your Ingersoll-Rand engineer for the complete Axi-compressor story. Or send for Bulletin 11003 on Type L units or Bulletin 11015 on Type H units.



Wyandotte Chemicals Corporation, Wyandotte, Michigan

SARAN LINED PIPE—"Superior under highly corrosive conditions...our own crews install it."

For the past seven years, Saran Lined Pipe has carried highly corrosive acids and processing chemicals for Wyandotte Chemicals Corporation, Wyandotte, Michigan. In one area, Saran Lined Pipe has carried monochloroacetic acid continuously since 1955 *without a single lining failure!*

"Saran Lined Pipe has given us superior performance under highly corrosive conditions," says Mr. Charles H. Culnane, Plant Superintendent. "It's the most practical transporting medium available for use under severe conditions and temperatures which reach as high as 180° F.

"Saran Lined Pipe has high structural strength, which means maximum safety for personnel working in the area. Other, more fragile pipe could break if accidentally hit, but not Saran Lined Pipe. And because it needs a minimum of support, labor and material costs to install it are less than with other kinds of pipe."

"All Saran Lined Pipe is installed by our own crews, using regular pipe fitters' tools and techniques," explains Mr. William Tucker, Maintenance Manager. "It can be easily installed by any experienced pipe man. As we need them, we cut short sections to length from our ten-foot stock sections of different size pipe. Thus we can install Saran Lined Pipe when required, not at a supplier's convenience!"

For chemical piping systems that will provide years of trouble-free service—consider Saran Lined Pipe. Saran Lined Pipe, fittings, valves, and pumps are available for systems operating from vacuum to 300 psi, from below zero to 200° F. They can be cut, fitted and modified easily in the field without special equipment. For more information, write Saran Lined Pipe Company, 2415 Burdette Avenue, Ferndale, Michigan, Dept. 1572AK8-21.

THE DOW CHEMICAL COMPANY



Midland, Michigan

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You buy a Sperry Filter Press for a specific application. Then you find yourself improving your product—making process changes—adding new products—saving vital production dollars and increasing income.

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TYGON[®] *Airless* VINYL

Cuts painting costs 30% to 50%

Airless spraying of protective coatings is based on the principle that liquid forced under pressure through a restricted opening tends to atomize. The garden hose and shower head are homey examples. A few years ago, it was found that paint forced through a specially shaped nozzle at pressures of 1000 psi or more, broke into millions of particles and could be deposited like a fine mist on surfaces to be painted. This new spray process made possible the use of heavier-bodied coatings with less solvents; it eliminated material "bounce-back"; it reduced overspray to a minimum. In application after application, material and labor costs were cut anywhere

from 30% to 50% over normal air spray methods.

Practically any paint can be airless sprayed. But where resistance to corrosive fumes, acid and alkali attack, are involved, it takes a coating especially formulated for airless spray application to do the job. *Tygon Airless Vinyl (Series "AV") meets every requirement for airless spray application*, plus offering corrosion-resistance properties unmatched by any protective coating. Possessing exceptional wet to dry film homogeneity, Series "AV" builds a protective film free from pin holes, even in thin films—and films of virtually any desired thickness can be built in a single application!



CHECK THESE MONEY-SAVING . . . SURFACE-SAVING FEATURES!

UNMATCHED CHEMICAL RESISTANCE

Resists acids, alkalies, oils, greases, water and alcohols

ANY DESIRED FILM THICKNESS

Up to 20 mils or more dried film if desired, but rarely are more than 6-10 mils required

DRIES QUICKLY

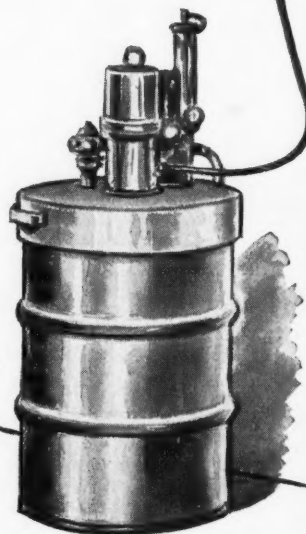
Series "AV" dries to touch in 10-15 minutes

LONG SHELF LIFE

Solids remain in suspension. Minimum agitation required.

LOWEST APPLIED COST

Savings up to 30%-50% in labor and materials. Tygon AV Series vinyl can be applied to a 5 to 7 mil thickness in a single coat using conventional spray equipment.



COATINGS AND LININGS DIVISION



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448-G

Chementator

Isocyanates get more capacity as nonpolymer demand grows

Besides the well-known market in urethane foams, isocyanate sales for chemical intermediates are also zooming. As a result, Mobay Chemical Co. is more than doubling capacity for various isocyanates at New Martinsville, W. Va., and Ott Chemical Co., Muskegon, Mich., will soon expand capacity for specialty isocyanates by 200%. Among Mobay's additional output of several hundred tons per month will be *m*- and *p*-chlorophenyl isocyanates, octadecyl isocyanate and phenyl isocyanate. Ott's current output of substituted aryl monoisocyanates will be supplemented by the aliphatics, ethyl and methyl isocyanates.

These isocyanate chemicals are finding most use in pharmacological areas, e.g., drugs for humans and animals, and as plant and animal pesticides.

They can form carbamates as well as urethanes, which is the basis for a new class of carbamate-type insecticides (such as Union Carbide's Sevin). These materials are expected to displace chlorinated and phosphated insecticides because of the carbamates' combination of effectiveness and safety.

It's estimated that the isocyanate market in intermediates is as large and fast-growing as the more-publicized coatings market for tolylene diisocyanate. This would put intermediate consumption at 5-10 million lb./yr. Growth rate of better than 30%/yr. through 1965 is forecast for intermediates, as well as for other volume uses of isocyanates (except for rigid urethane foams, expected to sprint more than 75%/yr.).

Countercurrent pulping proves out on soda process. Is kraft next?

Taking continuous pulp digestion one step further, Australia's Associated Pulp & Paper Mills, Ltd., has come up with a countercurrent digestion process. It was accomplished by modifying a

Kamyr continuous digester, which usually operates cocurrently (*Chem. Eng.*, Sept. 21, 1959, pp. 131-139).

Main advantages of countercurrent digestion are reduced chemical consumption and a whiter pulp that can be bleached without further washing. The Australian development, however, was made with a soda process. Industry men are now wondering if these advantages could be obtained in a kraft process, since most Kamyr units in the U. S. are built for kraft operation.

Since kraft pulping chemicals are recovered, reduction in chemical loss from the digester would only mean a reduced load on the recovery plant. (In soda process, spent liquor is discarded, so digester loss reductions are more significant.)

But there are indications that countercurrent kraft pulping might effect a saving in bleach chemicals, since sulfides are removed from the pulp as they are formed in the digester. According to trade reports, mill-scale tests of this system will be taking place shortly in the U. S.

In Associated Pulp's process, water is injected into the bottom of the digester, washing the descending pulp before blowdown. The general flow of cooking liquor is upward, with spent black liquor being withdrawn from the top screen belt of the Kamyr unit.

Gulf Coast gets ready for another ethylene-propylene complex

Emphasizing the growing string of claims that oil companies are staking out in the chemical business, Gulf Oil Corp. has announced plans for an extensive petrochemical complex on Cedar Bayou, Tex., about 30 miles east of Houston. From the initial description, it appears that Gulf has in mind an integrated complex like the one Monsanto is now building on Chocolate Bayou, 35 miles to the south.

First unit at Gulf's site will be a 400-million-lb./yr. ethylene unit, which is slated to be completed by mid-1963. A high-purity propylene unit will be added shortly afterward.

ACRYLIC FORMULATORS:

Shell Chemical's new Pent-Oxone* and Pent-Oxol* high boiling solvents give you flexibility never before possible in high-low solvent systems for acrylic lacquers

New Pent-Oxone solvent is Shell's remarkable keto-ether. New Pent-Oxol solvent is a glycol ether.

Both are true high boilers which impart gloss to acrylic lacquers. They virtually triple the number of effective acrylic solvents you can choose from in the high boiling range.

For details, see below—and send for Shell's new technical bulletins.

AS YOU KNOW, high-low solvent systems for acrylic lacquers place a heavy burden on high boiling solvents. For years, ethylene glycol monoethyl ether acetate has carried most of this burden alone.

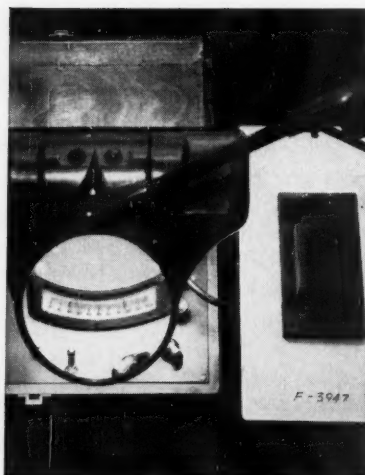
Now, Shell Chemical has developed two new high boilers which lighten this load and give you a flexibility which has hitherto been missing in acrylic lacquer formulation.

Solution viscosity data

Both Pent-Oxone and Pent-Oxol solvents are highly active. Here is how they compare with EGMEE acetate in solution viscosity (cps.) for three widely used Rohm & Haas acrylic resins:

	A-21	B-44	B-66
Pent-Oxone solvent	22	20	15
EGMEE acetate	26	23	16
Pent-Oxol solvent	30	25	25

All three resins were reduced to 15 per cent by weight as follows: A-21 with 45 parts toluene, 5 parts butyl alcohol and 50 parts indicated solvent; B-44 with 26.5 parts toluene and 73.5 parts solvent; B-66 with solvent alone.



Unrubbed acrylic lacquer with Shell's Pent-Oxone solvent, left, gives greater gloss reading (77) than identical formulation with equivalent amount of EGMEE acetate (72). Pent-Oxol solvent gives similar high gloss levels in acrylic lacquers.

Gives high gloss levels

Acrylic lacquers using Pent-Oxone or Pent-Oxol in the solvent system are characterized by gloss levels higher than can be obtained from any other high boiler at equal concentration.

These gloss levels remain high under a wide variety of application conditions, such as force dry time and temperature, spray room temperature, top-coat thickness, primer smoothness, pigmentation and operator efficiency.

This feature readily translates into lower manpower and elapsed-time costs in rubbing operations.

New technical bulletins

New technical bulletins are available from Shell on Pent-Oxone and Pent-

Oxol solvents. Bulletin A deals with the physical properties of these products. Bulletin B deals with their use in acrylic lacquers.

For these bulletins, plus samples of Pent-Oxone and Pent-Oxol solvents, write to any of Shell's 9 Industrial Chemical Division offices or directly to Shell Chemical Co., 110 West 51 Street, New York 20, New York.

*Trademark, Shell Chemical Company

A Bulletin from
Shell
Chemical
Company
Industrial Chemicals Division



Already supplying ethylene from its Port Arthur, Tex., refinery, Gulf will be doubling its capacity with the Cedar Bayou plant. Significantly, this is the first petrochemical plant the company has located outside one of its refineries. This break-away from refinery operations parallels the recent creation of a separate petrochemical department within the company.

Ethane and propane feedstocks for the new complex will be obtained from natural gas brought from West Texas via an 850-mi. pipeline. They will be extracted at Gulf's Mont Belvieu gas processing plant, then piped to the Cedar Bayou installation.

Gulf has acquired 1,000 acres for the new complex, most of which has been earmarked for its own chemical expansion. A portion of the land, however, is being reserved for olefin customers that the firm hopes to attract to the area.

A high-melting alloy—containing 98% tungsten and 2% molybdenum—that can be rolled into thin sheets at only 1,800 F. has been developed by Oregon Metallurgical Corp. Ductility of the alloy is attributed to fine tungsten grain structure, obtained in a special centrifugal casting furnace.

Fluorocarbon solvents bid for role in do-it-yourself drycleaning

Look for strenuous efforts by manufacturers of fluorinated solvents to crack the budding market for drycleaning agents being opened up by the advent of coin-operated drycleaning machines. Perchloroethylene, the common drycleaning solvent, appears to have the inside track, but fluorocarbon makers are banking on better performance to win acceptance for their more-expensive products.

Most of the big names in household appliances are now introducing, or seriously considering manufacture of, coin-operated drycleaning machines. Frigidaire Div. of General Motors Corp., for example, recently disclosed it has a machine, using perchloroethylene, that has a cleaning cycle of only 20 min. Most other chlorinated-solvent processes need about 50 min. for a complete cycle.

Fluorocarbon makers Du Pont and Allied Chemical claim 20-min. cleaning cycles for

solvents such as trichloro-trifluoro-ethane. But Frigidaire's use of increased centrifugal speed to get improved performance out of the cheaper perchlor may have temporarily taken some of the steam out of the fluorocarbon campaign.

Just how short Frigidaire's cycle might be if a fluorocarbon were used is academic at this time because the greater volatility (which makes the drying time so much faster) also makes it impossible to recover this material in a system designed to handle perchlor.

One promising avenue still being explored is blending of fluorocarbons with hydrocarbon solvents to get an agent with quick-cleaning properties that can be used in standard recovery systems.

In countermoves completely across the country, New York-based Allied Chemical Corp. and California-based Oronite Div. of California Chemical Co. will build phthalic anhydride facilities on opposite coasts: Allied at El Segundo, Calif. and Oronite at Perth Amboy, N. J.

Tire-cord potential whips up interest in higher polyolefins

Goodyear Tire & Rubber's disclosure to CE that it is now road-testing tires with polyolefin cords adds an additional note of urgency to the intensifying search for improved olefin polymers.

The tire-cord market represents a potential 400-million-lb./yr. target, so every company with any interest in olefin polymers is actively working on tire-cord candidates. But because the market is so alluring, little is being said about investigations now under way.

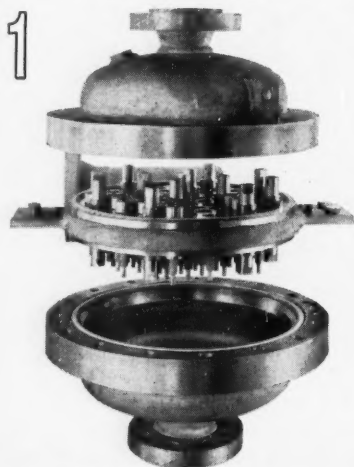
Goodyear, which is producing certain polyolefin fibers on a pilot-plant scale, won't say which ones it is working on. B. F. Goodrich will say only that it has obtained polyolefin cords from an unnamed supplier and has built "some" experimental tires.

Polyolefins' advantage in tire cords would be a price lower than for nylon or rayon currently being used. But many problems remain before an acceptable polyolefin can be found, including lower temperature resistance, difficulty in binding into tires, and flat spotting.

(Continued on page 60)

Dorr-Oliver presents:

NEW DEVELOPMENTS FOR THE HYDROCARBON PROCESSING INDUSTRIES



For Catalyst Recovery:

The TMC DORRCLONE®

Introduction of the TMC DorrClone for catalyst recovery represents an important breakthrough in processing technology. Its development is the result of years of research culminating in the production of a special miniature ceramic cyclone, which, together with other features of design, overcomes the problems of thermal and mechanical shock.

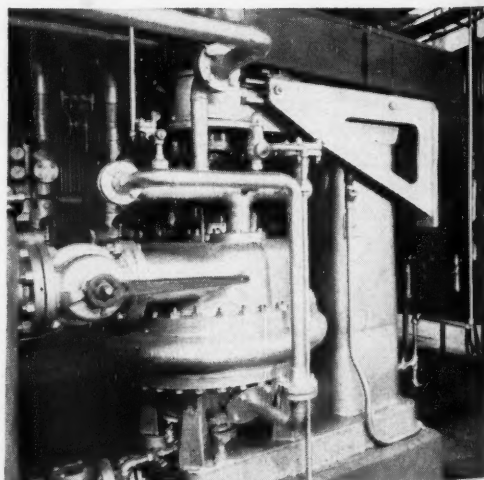
Units contain 60,180 or 300 miniature manifolded cyclones. Each individual cyclone will clarify approximately 1 GPM. The assembly is designed to operate at 150 psig and 850°F. Construction conforms with API practices. Installation of a TMC DorrClone reduces recycle to the cracker, resulting in higher throughputs and lower carbon formation.

2

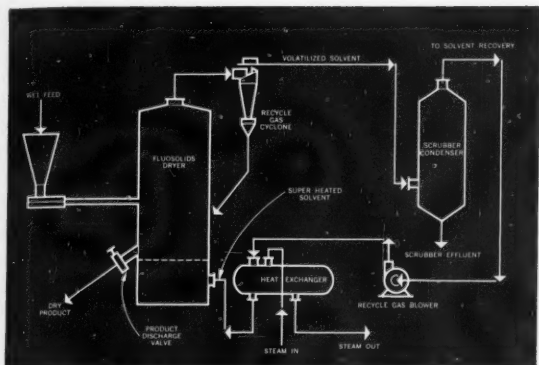
*For Carbon Removal from
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PC-20 MERCO® PRESSURE CENTRIFUGE

The PC-20 Merco allows processing of materials which have formerly been considered too difficult for centrifugation. It provides for continuous, completely automated carbon removal from heavy distillate bottoms. Advanced design accommodates high temperatures — up to 450°F — and high pressures — up to 150 psig.



3

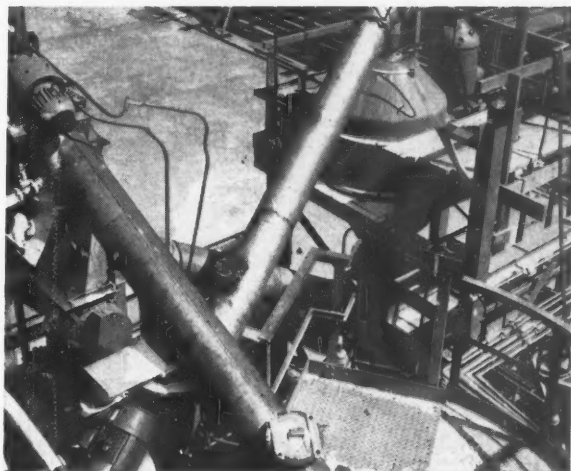


For Plastics Drying: The DORRCO FluoSolids® SYSTEM

Application of the FluoSolids system provides an efficient, easily controlled method of drying heat sensitive plastics by vaporizing the solvent in a fluid bed. Heat for vaporization is supplied by recycling superheated solvent back to the dryer. The system allows complete recovery of valuable constituents with minimum requirements in equipment, space and labor. Ease of sealing against loss of volatile solvents is a special feature. The flow chart illustrated represents a typical installation. Materials that can be handled include polyvinyl chloride, polystyrene, polycarbonates, polyethylene and polypropylene.

4 For Polymer Dewatering: The MERCONE® SCREENING CENTRIFUGE

This is a compact, self-contained unit that combines the features of a centrifuge and screen. High centrifugal force overcomes the capillary attraction of liquids to solids, reducing moisture to very low levels. As a result, heating requirements in drying are reduced and dryer capacity is increased. Photo shows an installation at the plant of a leading plastics manufacturer.



TO: DORR-OLIVER INCORPORATED
STAMFORD, CONNECTICUT

Att: Mr. O. W. Johnson

Please send me more information on the
Dorr-Oliver products checked below.

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- ☐ PC-20 Merco® Pressure Centrifuge
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DORR-OLIVER

WORLD-WIDE RESEARCH • ENGINEERING • EQUIPMENT

Polypropylene is being tried experimentally, but its strength diminishes at temperatures generated by high driving speeds. Goodrich reports, however, that it has improved the strength of polypropylene cords 400% by using special primer coatings.

Among the higher polyolefins, interest centers on polymers of 4-methyl-1-pentene and 3-methyl-1-butene. In a paper given recently at the Congress of Pure & Applied Chemistry, held in Montreal, B. D. Ranby of the Empire State Paper Research Institute, Syracuse, N. Y., discussed the 1-pentene polymer, which is easy to prepare using Ziegler type catalysts. The material has a high melting point (490 F.), is clear, light and flexible. Price of the 1-pentene monomer is around 15-20¢/lb., but would undoubtedly be lower if there were larger markets.

The polymer of 3-methyl-1-butene loses tensile strength slower with rising temperature than the 1-pentene polymer, but is much harder to polymerize.

Another possibility, being pushed by Houdry Process Corp., is the polymer of 3,3-dimethyl-1-butene. This material has a melting point around 700 F.—highest of any known polyolefin. Houdry, which makes the monomer via its own dehydrogenation process, is distributing samples of the olefin for development.

Aerojet-General Corp. will be the prime contractor for the first phase of the NERVA nuclear rocket engine program. Initial six-month, \$6.3-million contract will cover the preliminary design steps. Westinghouse will have responsibility for nuclear portion of the work under a subcontract.

Wave of developments aims at salvaging water that's now wasted

To increase this country's water supply, look to water that's already fresh. That seemingly obvious principle is the common thread that ties together three developments now being rushed in an effort to build up our diminishing reserve of fresh water.

This approach is quite different from the vigorous program being carried on to wring fresh water from the sea. Some observers believe that these latest developments point up a case

long argued by advocates of water re-use: if a fraction of the money that is now being spent on desalination projects were spent on less-glamorous water reclamation programs, vast additional amounts of fresh water would be made available at a fraction of the \$1/1,000 gal. that desalted water now costs. The developments:

1. Save irrigation water—California Research Corp., a subsidiary of Standard Oil of Calif., has just introduced a sealant aimed at saving the estimated 1 trillion gal. of irrigation water that is lost each year by seepage through the soil.

The material is identified only as an emulsified petroleum compound with special additives. It is claimed to reduce water seepage through earthen canals 65-95% by forming an impermeable membrane at a predetermined depth in the soil. It is applied to ponds or ditches when they are filled with water (either still or flowing), at a cost of only a fraction of the \$1-3/sq. yd. for a lining of concrete or asphalt.

Because the membrane is formed deep in the soil, it is immune to damage from equipment, or animals that might venture into a canal. The sealant is said to have no effect on humans, animals or crops, is estimated to be effective for five years, at which time it can be renewed.

2. Re-use sewage water—Water-lean Los Angeles is trying out a secondary sewage treatment process that may eventually allow it to re-use much of its 280 million gal./day of waste water.

Treatment uses algae to cut by 100-150 ppm. the concentration of inorganic ions remaining after conventional sewage processing. According to U.C.L.A. professor Albert Bush, who developed the process, the reduction compensates for the ion buildup resulting from evaporation during normal use, and thus would permit recycling.

Process is being tested in a 100-gal./day pilot plant, downstream from conventional sedimentation and oxidation steps at Los Angeles' Hyperion sewage plant. Bush believes process will increase operating costs only 10-15% at plants that already provide full conventional treatment.

In the pilot unit, algae are grown in a U-shaped pond 200 ft. long and 20 ft. wide. Key to successful growth: supplying pond with carbon dioxide, produced by burning methane coming from primary treatment steps. Among ions removed are calcium, magnesium, bicarbonate, nitrate, sulfate and phosphate.

It doesn't appear, however, that the algae can solve one of the biggest water-treating problems—elimination of synthetic detergents from sewage water.

3. Remove detergents via electrodialysis—Another secondary sewage treating process, this one

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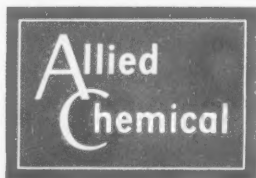
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Standard: 60° and 66° Baumé,
99% H_2SO_4

Diamond: 66° Baumé
Reagent, ACS

MURIATIC (Hydrochloric) ACID

18°, 20° and 22° Baumé, Standard
Diamond, Crystal and Reagent Grades

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Wet Process, 75%, Com'l
and Fertilizer Grades

Food Grade, 75%

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NITRIC ACID

Diamond: 36°, 38°, 40°, and 42°
Baumé

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fuming grades

Photo-Engravers' Grade
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GENERAL CHEMICAL DIVISION

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In Canada, Allied Chemical Canada, Limited

aimed at synthetic detergents, centers on electro-dialysis.

Ionics, Inc., Cambridge, Mass., has just received a contract from the Public Health Service to adapt the ion-exchange membrane process, which the firm developed for water desalting, to secondary treatment. Specific target is removal of detergents and other wastes that pass through conventional biological oxidation processes.

Involved in the \$43,000 program will be a pilot-plant study to prepare cost estimates for 10-million- and 100-million-gal./day treating plants.

Upping the ante in the tire-cord battle, American Viscose Corp. has announced a Tyrex rayon cord that is 15% stronger than current rayon cords. New yarn has a tensile strength of 40 lb. in the 1650-grade used for the new two-ply tires.

Speedy machines resurrect data—old and recent—buried in files

Experts on information retrieval, turning to high-speed electronic equipment to aid literature searching, have made giant strides in increasing the capability of retrieval systems. Two of the latest:

- International Business Machines has an elaborate new system consisting of an input converter, index, and image file. Document images, keyed to an index record, are stored in a file module that holds 990,000 images on 10,000 film strips. A search unit finds records in the index that match desired key words; those selected for examination in full have their image automatically transferred to a card that can be studied with a viewer or reproduced full size.

Since the maze of equipment needed for the system must necessarily be centrally located, its one possible drawback may be time lag from the moment the machine finds the index records until they can be reviewed and returned for document copies to be made.

- A machine developed by the National Bureau of Standards permits the searcher to be in full control of the search program. A film matrix containing 18,000 abstracts and serial numbers is mounted on a drum. The searcher views against a

strong light a series of punched cards containing the relevant key words. An illuminated hole represents an abstract of the subject matter desired.

The searcher can then set the controls so that the appropriate abstract is projected on a viewing screen. He may then have a copy made of any specific abstract; or note the serial number for later retrieval of the original document from a storage machine.

Because the results are available immediately, the searcher can act more effectively. He can detect and adjust for contingencies such as misinterpretation of index terms, interference from unforeseen information, volume of information and modification of needs by facts gained.

Public Health Service to seek funds for pollution crackdown

The new pollution control law recently signed by President Kennedy is probably the precursor to increased action against both industrial and municipal violators of pollution laws. The Public Health Service, which administers the law, is readying a request for additional Congressional appropriations to beef up its policing operation.

Key provision of the new law as far as industry is concerned is the extension of federal authority in pollution control to "all navigable waterways." In the past, courts have ruled that this includes almost any body of water on which a canoe or log can be floated.

Previously, PHS antipollution action was limited to 4,000 interstate rivers and lakes. Under the new law, the PHS can—at the request of a state governor—take enforcement action against communities on another 22,000 intrastate rivers, lakes and coastal waters. In addition, any city or town on an interstate waterway can now request federal aid. Formerly, only a state governor or state pollution board could make such a request.

If Congress grants PHS additional funds, the agency will establish regional offices from which surveys of intrastate waterways will be made to determine pollution levels. PHS will then recommend ways to clear up any pollution found. If voluntary action fails, the Secretary of Health, Education and Welfare now has the authority to issue a cease-and-desist order.

After six months, the secretary may then take the case to court to enforce compliance.

For More Industry & Economic News . . . p. 64

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Problem: Paint jobs ruined by airborne dirt in spray booth

This plant needs make-up air! If the exhaust fans in your paint shop remove air faster than you replace it, they cause a vacuum. The vacuum sucks in dirt and dust every time a door or window is opened. Your plant needs make-up air...a supply of new air to replace exhausted air and cancel out vacuum.

Without make-up air, you get a chain reaction of vacuum problems. Violent cross drafts...Infiltration of dirty air or fumes from outside, and from one plant section to another...Heat loss...Unhealthy workers...

Low morale...Costly absenteeism.

Solution: install separate fans to supply make-up air. They cancel out the vacuum, give your plant balanced ventilation. These fans should be part of a complete make-up air system that tempers and cleans the incoming air.

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CPI PUTS CONTROL HARDWARE ON WHEELS IN NEW MOBILE APPROACH TO PROCESS REFINEMENT

Portable trailers are bringing a new look to process analysis and control. Here's a roundup of who's doing what with this concept.

Living in a nation-on-wheels, Americans solve many problems through the mobility that wheels can give.

For proof that this is as true in the CPI as anywhere else, take a look at the niche that mobile trailers are carving for themselves in process analysis and control applications.

Easy-to-move vehicles carry control hardware out into the plant—right to the processing units—and house the tools during their use. Specific van-housed operations range from simple analyzer test-

ing to data reduction by compact digital computers. Phillips Petroleum Co. even took a notable, if temporary, step further by using a van briefly for on-line computer control of an ethylene plant.

Mobility is not the only feature of these vehicles. Industry experts cite other advantages, saying that mobile vans:

- Permit instrumentation bugs to be worked out in seclusion.
- Provide a handy field office for the technical people involved.
- Obviate overcrowding of control houses.
- Provide a convenient place to train operators in analyzer use.

Petroleum firms have led the way so far: Standard Oil Co. of Ohio, Standard Oil Co. (N. J.) and Shell Chemical Co., as well as Phillips, have all disclosed activity in this area. And many of the big chemical firms aren't far behind. Monsanto Chemical Co. already has a mobile van at its Texas City, Tex., plant, and both Allied Chemical Corp. and Du Pont have potential projects in the idea stage.

► **New Avenue**—A big boost for the mobile-van trend has just come from Dresser Industries, Inc.'s, Southwestern Electronics Div. Latter, which built Monsanto's trailer before becoming a Dresser division and also has constructed a van for Shell, now offers data-recording trailers on a lease basis. Result: firms can garner benefits of mobile data-handling equipment without investing capital.

Dresser says minimum lease periods will generally be less than a year. The firm will determine lease costs by prorating unit selling prices—about \$50,000-\$125,-

000—over a normal payout period.

Typifying one of the ways in which existing vans have already been used, Dresser's vehicles will receive raw plant data, tag them with identification and calibration information, and yield an output that can be processed at a specific, central computing facility.

Here's a quick look at activity that has already taken place with mobile units in the CPI.

► **Emphasis on Analyzers**—Standard Oil of Ohio operates two trailers; their use centers about new stream-analyzers, rather than data processing per se.

Sohio's mobile program has undergone considerable evolution. Originally, the main aim was analyzer evaluation—determining accuracy, range, reliability and similar factors under real operating conditions.

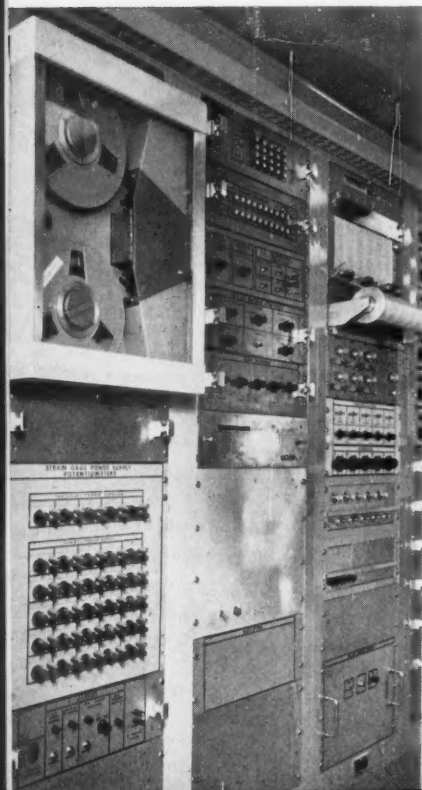
But the company began spending more and more time in finding how the instruments, once tested, could best be put to use. And today, Sohio makes much use of trailer-mounted analyzers for process evaluation.

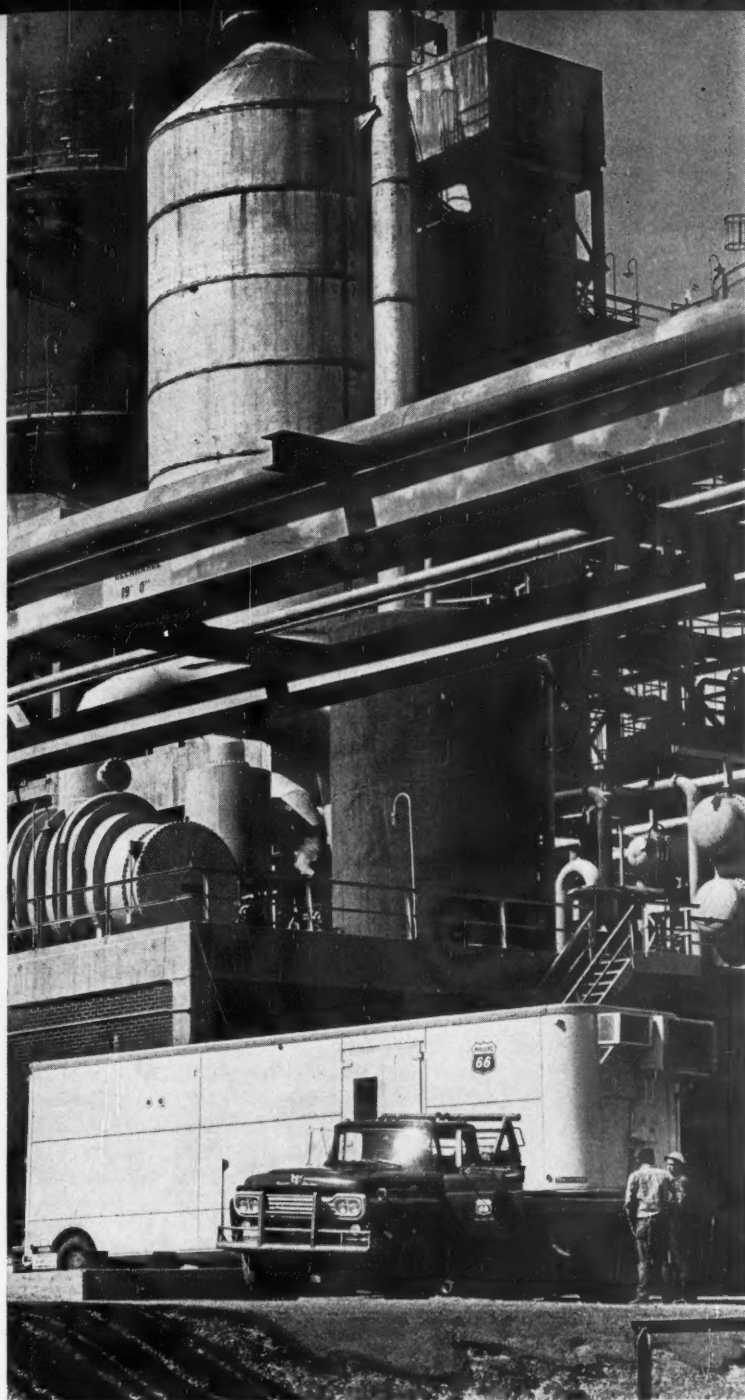
For instance, the firm recently lowered viscosity deviations in streams from a vacuum distillation unit by studying the operation with a trailer that had been fitted out with a bank of viscometers. In an earlier application, a trailer laid the groundwork for chromatographic control of light-ends fractionators.

Another company whose mobile program emphasizes analyzers is Standard Oil Co. (N. J.). Subsidiary Esso Research & Engineering Co. developed a portable "room" (it has no wheels, is moved from location to location by a crane) to house analyzers during applications evaluation.

The unit was not built for testing the instruments themselves; Esso's aims were to learn where analyz-

Interior of Dresser Industries van typifies high degree of instrumentation these vehicles can offer.





Phillips Petroleum's trailer, on location near cat cracker at Borger, Tex., first proved its worth at firm's Sweeny, Tex., ethylene plant.

ers should be permanently installed, then—most important—document the necessary supporting economics and, finally, provide a site for training operators in analyzer use. Like Sohio, Esso has since put its room to work on process analysis and systems testing.

► Or, Emphasis on Data—In mov-

ing towards more and more process evaluation, Esso's and Sohio's programs are approaching those of Shell Chemical, Monsanto and Phillips. Here the emphasis is on gathering raw process data and reducing them to more meaningful form, with analyzers performing essential but not central roles.

Shell, for instance, has just received a complete mobile system from Dresser, for data gathering and interpreting. Unit includes analog and digital input equipment, a Packard-Bell Computer Corp. PB 250 digital computer, and magnetic-tape or typewriter output equipment.

This van can receive up to 60 measurement inputs—either electric or pneumatic—and will provide on-the-spot data reduction. Without disclosing details, Shell reports it will operate the unit at its Deer Park, Tex., plant.

Monsanto's van is a data logger; it is used at the company's Texas City, Tex., plant for broad, general investigations aimed at bettering process control. Like the Shell unit, it can handle up to 60 inputs. The van converts these to digital signals and records the latter on tape, which Monsanto then processes either at its own large digital computer in St. Louis or, on a contract basis, at a closer facility.

Phillips calls its trailer a mobile process-plant testing laboratory. It collects and reduces data, also develops and evaluates means for process improvement. The vehicle houses: (1) stream analyzers, (2) on-stream data logging and reduction equipment built around a North American Aviation, Inc., Recomp II digital computer, and (3) facilities to experimentally evaluate improved control techniques and systems.

Company first used the van at its Sweeny, Tex., ethylene plant. The mobile unit studied thermal-cracking furnaces, investigating such variables as carbon buildup in furnace tubes, tube skin temperatures and effluent-stream composition.

Improved plant-operating procedures suggested by this study have yielded a permanent 10% increase in ethylene output—thus paying out the experimental effort in three months. The program indicated that another 6% could be realized if the computer remained permanently on-line. Latter was not economical, however, and Phillips has since turned the attention of its van towards bettering of other process operations.—NPC

SYNTHETIC GUMS PUSH FOR TWO BIG MARKETS

In the next decade, water-soluble synthetic resins hope (1) to enlarge the nick they're taking out of big markets for starch and natural gums and (2) to build markets for themselves in new water-soluble films.

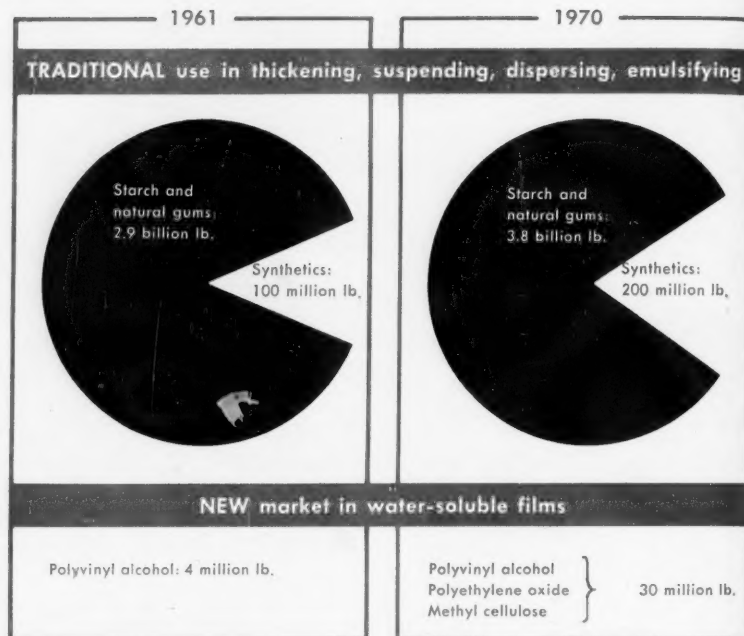
Synthetics have stepped up their bid for a bigger share of the 3-billion-lb./yr. water-soluble resin market—a market long dominated by natural products. Since the beginning of the year:

- Hydroxyethyl cellulose, one of the newer synthetic water-soluble resins, got a boost from each of its two producers: Hercules announced plans to add a multimillion-lb. plant at Hopewell, Va., to its existing 1-million-lb./yr. output. And Union Carbide Chemicals, whose capacity is 6 million lb./yr., cut 10¢/lb. off the price of most grades, bringing them to the 74¢/lb. level.

- Dow Chemical, only U.S. producer of methyl cellulose products, announced that its estimated 12 million lb. of capacity will be doubled when a new Plaquemine, La., plant starts up next month. Prices of some premium and standard grades, which ranged from 69 to 82¢/lb., will be as much as 13¢/lb. lower, and prepayment of freight will further reduce delivered cost.

- A copolymer of methyl vinyl ether and maleic anhydride, PVM/MA, joined the list of synthetic water-soluble resins when General Aniline & Film expanded its semi-commercial plant at Linden, N. J., and dropped price from \$3 to \$1.25.

Other major water solubles are carboxymethyl cellulose, polyvinyl alcohol, polyacrylic acids, polyvinylpyrrolidone, polyethylene oxide. But natural products, particularly starch, command most of the water-soluble business, even though synthetics should hit 100 million lb./yr. Synthetics have been able to



peck away at starch's position chiefly because their price and properties are easier to control. Increased capacities and lower prices announced this year are part of a growing effort to bring synthetic sales up to 200 million lb./yr. by 1970.

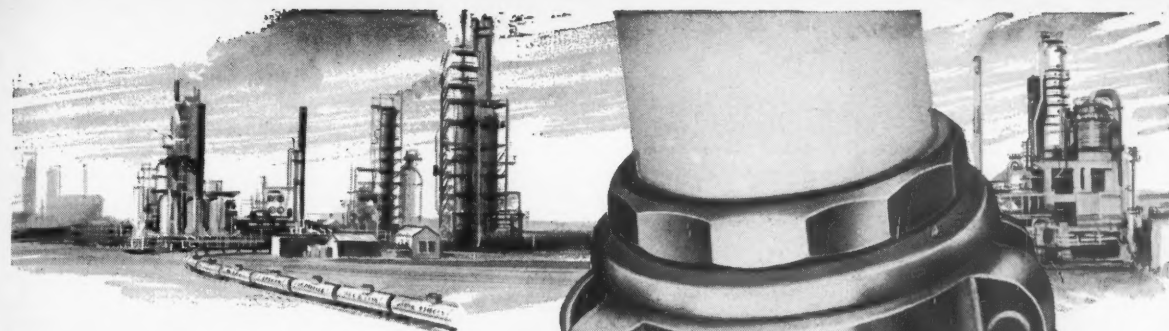
► **Traditional Markets**—Traditionally, the paper industry is the biggest market for water solubles; sizing, coating and other paper treatment accounts for about half of total sales. Next biggest are the food and textile industries. Water solubles are also used in detergents, adhesives, cosmetics and paints as emulsifiers, thickeners, suspending and surface-active agents. The big textile and paper markets are expected to provide a lot more growth for synthetics. In foods, however, they may not offer enough advantages to offset the relatively low price of natural products.

Natural products sell as low as 8¢/lb. while some synthetics sell

for as much as \$3/lb. But on a cost-performance basis, the synthetics have definite advantages for some applications. Textile sizing, for example, takes four times as much material if natural rather than synthetic resins are used. In addition, synthetics can help textile makers solve water pollution problems. Their BOD (biochemical oxygen demand), unlike natural resins', is acceptably low.

► **New Territory**—But a completely new domain—water-soluble film—is giving synthetics manufacturers something to conjure with. A film bag, containing a measured volume of ingredients, that will dissolve when thrown into cold water, has obvious advantages for the consumer of detergents, bleaches, dyes, insecticides and hard-to-handle chemicals. Estimates of the potential market for this type of soluble film range from 20 to 60 million lb./yr.

Already the water-soluble film



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Dominant markets will shift as decade progresses

1961

1970

Of 100-million-lb. total:

Market Line-up	Est. Consumption (Million pounds)
Detergents	20
Paper	18
Food	12
Textile	10

Of 200-million-lb. total:

Market Line-up	Est. Consumption (Million pounds)
Textile	50
Paper	40
Film	30
Adhesives	20

Synthetic water-soluble resin capacities

(Million pounds)

Polyvinyl alcohol	Air Reduction Chemical, Du Pont, Shawinigan Resins, Borden Chemical, American Aniline	66
Carboxymethyl cellulose	Hercules, Du Pont, Buckeye, Wyandotte, Dohnstamm, Brown	46
Methyl cellulose	Dow	24*
Hydroxyethyl cellulose	Union Carbide, Hercules	7
Polyvinylpyrrolidone	General Aniline & Film	1

*Including 12 million lb. to come on stream next month.

market consumes about 4 million lb./yr. of polyvinyl alcohol. And PVA for film is about to run into some competition from polyethylene oxide. Union Carbide, which introduced the resin a couple of years ago, recently developed techniques to make film from it. And now, Carbide's Visking division has started producing film under the trade name Hylox. Dow's methyl cellulose is another resin in the running.

► **Carboxymethyl Cellulose**—CMC is the most used of the synthetics with demand currently running at about 40 million lb./yr. Almost half of the market is in detergents, which market CMC—preventing redeposition of dirt on laundry—has all to itself. Drilling muds, textile, paper and food use follow in that order. Of these, drilling muds, textiles and paper are the strongest growth areas.

► **Polyvinyl Alcohol**—Last year, PVA capacity more than doubled. Though demand was under 30 million lb., capacity went up to 66 million lb. Air Reduction Chemical,

Shawinigan Resins and Borden Chemical all added capacity. Du Pont and American Aniline remained at 25 million and 1 million lb., respectively.

Producers expect most of their growth in adhesives (where PVA is already the major water-soluble synthetic), paper coatings and film.

PVA's properties vary with the degree of hydrolysis; partially hydrolyzed PVA has good water resistance and can be made insoluble if treated with an aldehyde. In addition, it has good adhesive strength and is used in both water-resistant and remoistenable adhesives.

PVA film is strong, clear, solvent resistant, impermeable to most gases and readily water soluble. One drawback has been its poor flexibility. The earlier soluble PVA films contained glycerin as a plasticizer in order to obtain flexibility, but it migrated when the film was stored thus leaving a brittle film. Borden has attacked the problem with its Lemoflex resin, a modified PVA. The modifier is ethylene ox-

ide, which acts as an internal plasticizer.

► **Cellulosics**—Excluding CMC, demand for the cellulosics is running at something over 25 million lb./yr. Methyl cellulose and hydroxyethyl cellulose account for major shares.

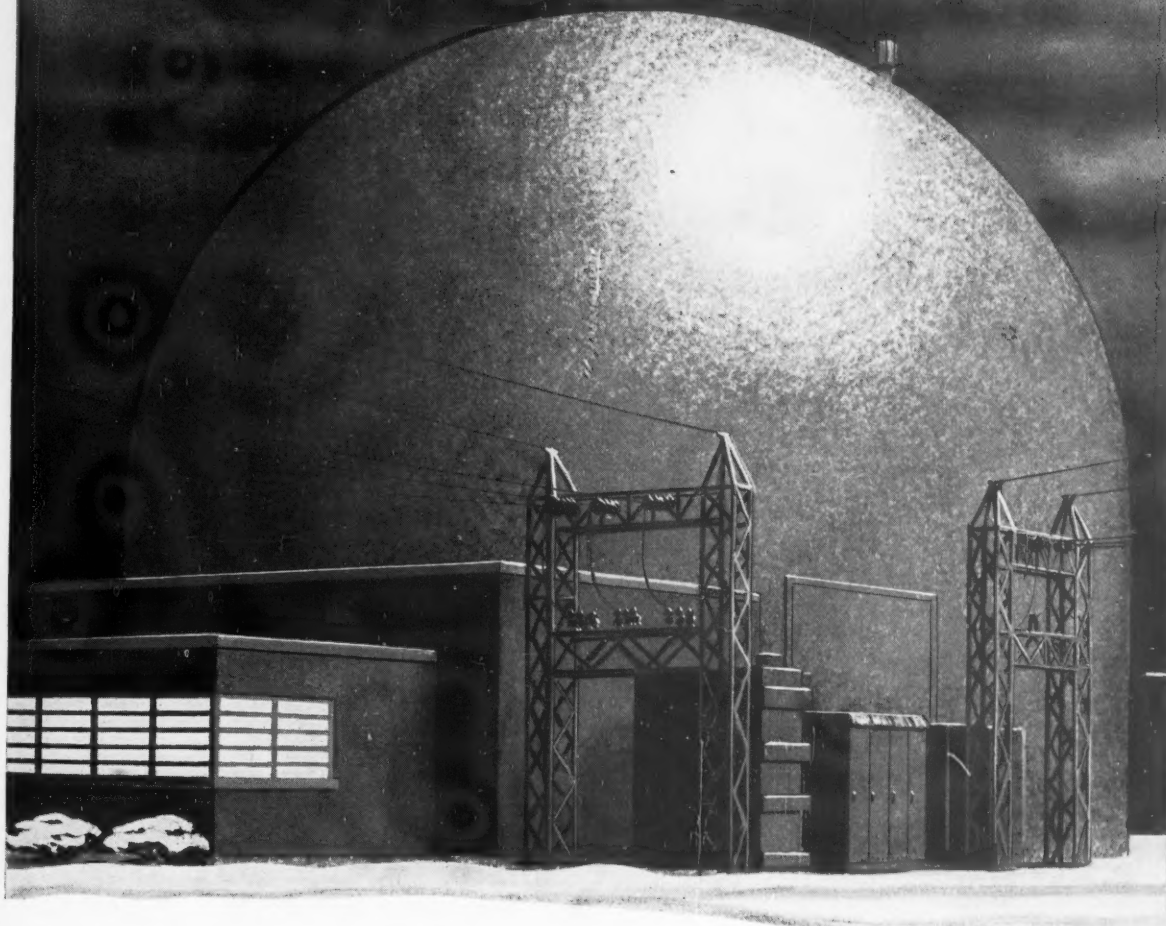
In the running for water-soluble film use, methyl cellulose has one immediate advantage over PVA and polyethylene oxide—Food and Drug Administration approval for food packaging. Also, it is the only water-soluble gum that has the property of thermogelation at elevated temperatures, making it useful for food processing where good heat stability is required. Among the industries currently using methyl cellulose are chemicals, paint, cosmetics, paper, pharmaceuticals, ceramics, and the adhesives industry.

Hydroxyethyl cellulose looks to many of the same markets, is described by its producers as the most efficient thickener among non-ionic cellulosics.

As for the other important synthetics: polyvinylpyrrolidone, of which General Aniline & Film is the only U.S. producer, finds its primary outlet—60% of a 1-million-lb./yr. production—in the cosmetic industry, mostly for hair sprays. A big future may be awaiting it in the beer industry; it is less expensive and can do the job that enzymes now do in preventing haze due to chilling.

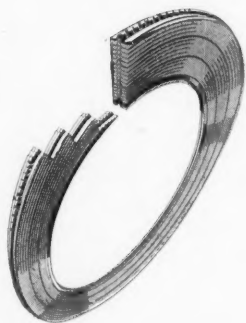
PVP appears to precipitate selectively those tannins which cause chill haze in beer and to improve the taste and taste stability. GAF hopes to offer a great variety of tailor-made products to satisfy a wide range of beers. However, in the future there may be yet another group of competitors.

Polyacrylic acid types of synthetic water-soluble resins are now used mainly for sizing nylon and polyester fibers. General Aniline & Film's new PVM/MA is looking for markets in photographic reproduction processes, cosmetics, and suspension and latex polymerizations. Carboxypolymethylene, introduced a few years ago by B. F. Goodrich, looks primarily to cosmetics and textile printing markets.—FA



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PLASTIC GRIDS HELP SOLVE WASTE-DISPOSAL PROBLEMS

Honeycomb-like units of polyvinyl chloride replace rock in trickling filter at paper mill. Result: effluent purified 7-10 times faster.

Big things are happening to that old standby of waste-disposal systems, the trickling filter. Both chemical and food plants faced with stream pollution problems should applaud the changes.

The Mead Corp. has increased capacity of such a filter from 700-1,000%, reduced installation costs, and permitted operation at higher temperatures, thus eliminating need for cooling of plant effluents.

Key to the new system is a polyvinyl chloride grid that resembles a huge honeycomb. Fabricated in 2 x 2 x 4-ft. units, these grids replace slag and rock used in conventional trickling filters.

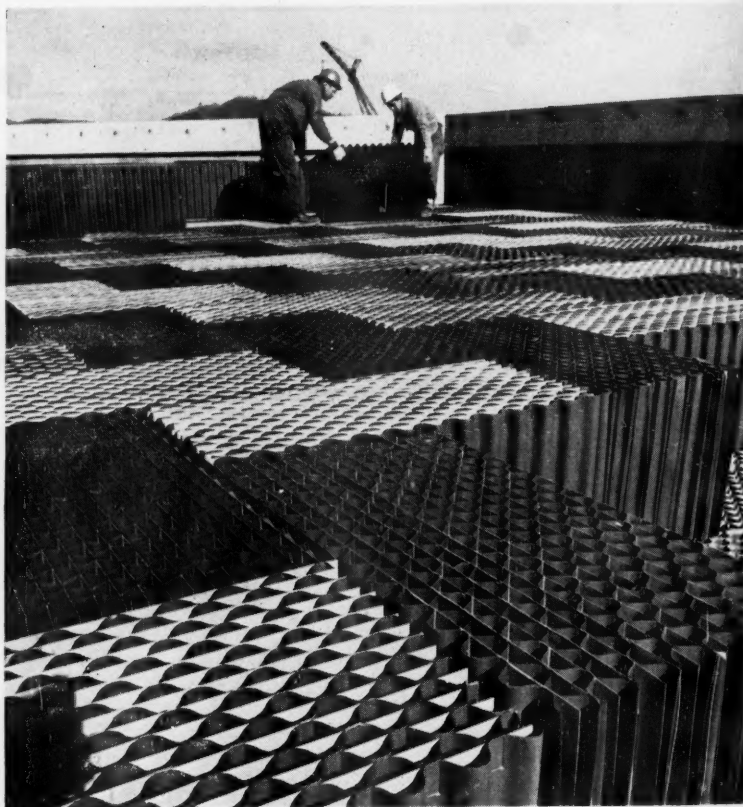
The new packing has greater surface area-to-volume ratios, permits better flow, decreases the possibility of plugging, and provides a better means of liquid distribution than a rock filter.

Each cubic foot of the filter-comb contains 40 sq. ft. of surface to facilitate more rapid bio-oxidation of waste-laden water than is possible with rock fill.

Developed by The Mead Corp. Research Center, Chillicothe, Ohio, the grids were recently installed in a new trickling filter at the mill of Rome Kraft Co., Rome, Ga. (*Chem. Eng.* June 26, p. 58).

The filter is octagonal in shape, 80 ft. across and 30 ft. high. It contains 6,250 of the 2 x 2 x 4-ft. grids. Successfully treating 16 million gal./day of kraft mill waste, the unit reduces the biochemical oxygen demand (BOD) enough to permit discharge into a stream following clarification by settling.

► **Pilot Operation**—Design of the filter and its packing was based on more than two years of study in a pilot plant comprising two 3-ft.-



Workmen lay final course to complete installation of 185 tons of polyvinyl chloride packing in trickling filter at Rome Kraft Co.

square x 30-ft.-high towers arranged to permit either parallel or series operation. Towers were constructed so that plastic grids could be inserted or removed easily.

Initially, two commercial packings were studied. One of them is 37½ x 37½ x 21 in. high, fabricated from individual sheets of polystyrene or Saran, with clear spacing between each sheet of approximately 1 in. Basic theory for its shape is that maximum BOD removal occurs when the waste is uniformly distributed over a large surface area with maximum transfer of oxygen.

The other contains a series of horizontal sheets (polyethylene or

polystyrene) 36 x 36 x 2½ in. deep, supported on five legs. Unlike the first, which creates laminar flow, this material introduces an area of turbulent flow between sheets.

Waste used in the pilot plant consisted of hot-well condensate plus miscellaneous waters from the pulping and washing operation of an integrated kraft mill. Biochemical oxygen demand of the waste was 250-300 ppm.

In the studies, it was shown that plastic filter media have a two fold advantage over conventional rock fill—less resistance to air flow and increased surface area.

As a result of the large voids in the plastic grids, air flow through

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the tower was relatively unimpaired so that in natural-draft plastic filters, less temperature differential is required for a particular rate of air flow.

The large surface areas permit extensive growths of organisms to exist in relatively thin sheets. This results in loadings and solids removals greatly in excess of those commonly associated with standard or high rate trickling filter installations.

Temperature of waste was also shown to play an important role in efficiency of the pilot filters. A rise from 105 F. (temperature of early studies) to 125 F. increased efficiency of the primary tower by about 30%, with a biological load 135% greater.

► **Materials Important**—During the pilot studies, it became apparent that certain factors in addition to process efficiencies should be considered in evaluating plastic filter media for pulping waste.

- Not all plastic materials are equally resistant to chemicals—polystyrene and polypropylene are attacked by turpentine, an ingredient in most kraft mill waste waters.

- Plastics such as Saran and PVC presented difficulties when injection molded, so could not be economically fabricated into one of the forms tested.

- Certain plastics have inadequate structural strength. Some of the units tested lacked structural bonding between sheets and within the sheets themselves.

Based on the data obtained in the pilot plant, Mead Corp. Research Center developed and has applied for a patent on the PVC grids employed in the new trickling filter at Rome Kraft. These were fabricated by the Plastics Division of B. F. Goodrich Co., and will probably be marketed by Goodrich to other eventual users.

Advantages claimed for the new system are many: most important are its lightness, porosity and increased surface area. Due to its increased capacity, the unit is considerably smaller than conventional trickling filters—Rome Kraft saved more than \$500,000 on installation costs.—AVG

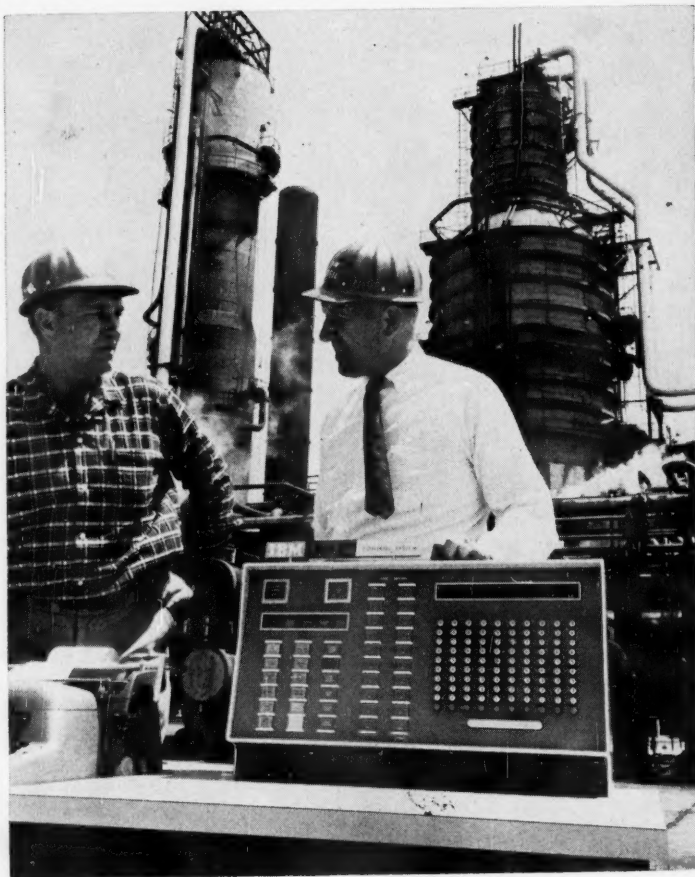
Spending Hits New Highs For Drug Research

Research expenditures for drugs for human use will rise to about \$227 million this year, according to the annual survey on research and development just made public by the Pharmaceutical Manufacturers Assn. A record \$206.5 million investment was made last year; the 1959 figure was \$197 million.

An additional \$5.4 million was spent in 1960 for research and development of veterinary drug products, and this figure is expected to rise higher during 1961 to \$5.8 million.

More than 10% of last year's funds went into research outside company laboratories. The industry spends about \$21 million to support studies in medical schools, hospitals and other research institutions.

Computer assumes direct control of distillation unit



By installing an IBM closed-loop process control system to regulate its 140,000-bbl./day crude oil distillation unit at Whiting, Ind., Standard Oil Co. (Ind.) is taking another step toward a completely automated oil refinery. A replacement for an open-loop system used on the same unit (Chem. Eng., Oct. 31, 1960, p. 48), this new system is built around an IBM 1620 digital computer coupled with random-access memory storage, and an input-output device to link computer to the controllers.

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PAPERS SET FOR "NEW CHEMISTRY" CONFERENCE

Upcoming Chicago meeting will tie together the many loose ends stemming from recent discoveries in chemistry.

Pictured below are the authors who will be appearing on the program of the conference on "New Trends in Chemistry," to be held in Chicago on Oct. 11-12. As the brief abstracts of the papers indicate, the objective of the meeting will be to present to practicing engineers the latest developments that

have been taking place in chemical laboratories throughout the world.

By such an exchange of ideas between scientists and engineers, the meeting will help cut the usual time-lag between scientific discovery and commercial utilization.

Arranged by Armour Research Foundation and *Chemical Engineering*, the conference is the second in a series of annual meetings designed by the editors of *CE* to familiarize the chemical processing industry with the latest profit-making techniques. Last year's meeting, cosponsored by Midwest Re-

search Institute, examined the "New Chemical Engineering."

A highlight of this year's Chicago meeting will be a banquet address by General John B. Medaris, president of The Lionel Corp. He will examine, from his vantage point as former chief of the Army's missile research, the most profitable way for smaller companies to invest their limited research funds. General Medaris will also discuss ways that companies can participate in government-sponsored research programs.

(Turn page for more on conference)



G. BARTH-WEHRENALP: *Inorganic Polymers*—Inorganic macromolecular systems, such as plastic sulfur, glassy selenium, and phosphonitrilic chloride rubber, will be reviewed—along with use of molecular engineering to develop a theoretical basis for new inorganic polymers. Work of American and Russian investigators will be discussed.

Dr. Barth-Wehrenalp is presently director of inorganic research for Pennsalt Chemicals Corp.



J. J. KATZ AND I. SHEFT: *Nonaqueous Chemistry*—Increasing application of nonaqueous solvent systems to chemical processes is made possible by advances in the understanding of these systems. Greater availability of resistant materials of construction and new methods of handling, have accelerated the use of these systems. Problems and needs of the atomic energy program in particular have supplied great impetus to work in this field. A few of the nonaqueous systems that are important to chemical research and industrial processing will be discussed.

Dr. Joseph J. Katz (top photo) is presently a senior scientist at the Argonne National Laboratory. He is the recipient of the American Chemical Society award for nuclear applications in chemistry for 1961. Irving Sheft (second photo) is a research chemist at the Argonne National Laboratory.



P. Y. FENG: *Radiation Chemistry*—Because of the unique nature of its reaction mechanism, radiation processing can sometimes initiate reactions not otherwise feasible. There are limitations, however, on the usefulness of this relatively new technique. The paper will examine these aspects, along with an introduction to the principles of radiation chemistry.

Dr. Feng is supervisor of chemical physics research at Armour Research Foundation.



H. P. GREGOR: *Ion Exchange Resins and Membranes*—This paper will discuss new ion exchange membranes and resins developed in the last few years. Newest uses for these materials will be emphasized, e.g., separation of amino acids, concentration of salt from sea water, production of potable water from brackish waters, and recovery of sulfuric acid from waste streams.

Professor Gregor teaches physical chemistry at the Polytechnic Institute of Brooklyn.



M. KILPATRICK: *The Expanding Field of Chemical Kinetics*—Development of the activated complex theory in terms of potential-energy surface barriers has created a useful theory of rate processes and a broad understanding of the general field. Topics to be discussed include fast reactions, oxidation of hydrogen and hydrocarbons, polymerization, nitration and sulfonation, and metal-water reactions.

Kilpatrick is now conducting research as senior chemist emeritus at the Argonne National Laboratory.



VLADIMIR HAENSEL: *Catalysis*—This paper will examine two aspects of catalysis: first, highly selective reactions that have become commercial successes through use of dual-function catalysts; second, the use of new tools such as infrared spectroscopy to gain knowledge of the intermediates in catalytic reactions. In processing hydrocarbons, dual-function catalysts make possible a substantial increase in reaction rates.

Dr. Haensel is director of process research for Universal Oil Products Co.



J. L. MARGRAVE: *Plasma and High-Temperature Chemistry*—Since the number of chemically plausible combinations of atoms at high temperatures (up to 100 million K.) is astronomically large, this paper will discuss preparation and identification of high-temperature species using plasma arcs, induction heaters, solar furnaces, shock tubes, flash heating devices and unusual flames.

Professor Margrave is engaged in teaching and research at the University of Wisconsin.

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Continuous processing . . . two big words in the world of chemicals . . . and one big headache when the processing has to stop unexpectedly. It's not just the pure pain in the neck that mechanical failure produces. It's the production costs that keep mounting during down-time.

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Results? Results!

For one thing, Reichhold has learned that TD-50's hardly know the meaning of the word downtime. Then, too, maintenance people like them for their ease of inspection and



The character pretending to inspect one of Reichhold's TD-50's is Sarco's ad manager, who normally wears a gray flannel suit. We're happy to see strainers used properly on this 14-trap manifold to protect the steam traps, even if they don't happen to be Sarco strainers.

service. And TD-50's don't require high quality steam to function. We don't want to sound like an advertisement, but it's this way: the TD-50 is so simply designed it has only one moving part; its performance is uniform; it operates equally well on heavy, light, or no condensate load—even against back pressures up to 50% of inlet pressures; it's so rugged that superheat, water hammer, vibration, or corrosive condensate won't affect it; if you should ever want to service a TD-50, a highly unlikely prospect, you can unscrew the cap, clean it, blow it down, and have it back on stream in 40 seconds.

MR. BERNOULLI HELPS BUILD A BETTER STEAM TRAP

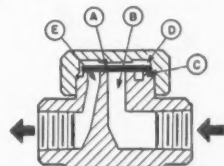
We may be a trifle tardy in bringing it up, but Daniel Bernoulli, who dreamed up the "Bernoulli Effect" about 250 years ago, deserves some sort of accolade from us here at Sarco. A plaque perhaps, or his name in the foyer floor tile. Daniel was a famous Swiss mathematical genius and he was probably a little hesitant about even mentioning his slightly offbeat discovery, the "Effect," in *Hydrodynamica* (1738).



If you happen to have a spool handy, you can perform the simple "effect" right at your desk. Lay a cardboard disc with a pin through it on the table. Place the spool over the pin and blow—hard—and lift. The disc won't fall until you stop blowing because the air under pressure expands between the end of the spool and the disc. The pressure in this space is actually less than atmospheric, and the sum of the downward forces is less than the upward force of atmospheric pressure acting upon the disc's bottom side.

Well, of course it sounds rather remote, but what seemed like a simple parlor trick to Bernoulli has made it possible for us at Sarco to solve steam trapping problems by the dozens. In our Sarco Thermo-Dynamic Steam Trap, Type TD-50, the cardboard disc is replaced by a stainless steel disc A, the spool tube by inlet tube B. The disc also acts as a valve and can seat on B, and also on outer seat ring C. When seated, the disc seals the inlet and the chamber D from the outlet E. Full attention now, because it could easily be your steam, condensate,

or air we're following here as it enters the trap, its pressure raising the disc and allowing fluid to flow radially across the underside of the disc. The velocity of air or condensate is comparatively low, exerting little influence on the disc, which remains



clear of the seat, allowing free discharge. Ah, but now steam enters the trap. Velocity increases greatly because of the steam's greater internal energy. Presto! The disc is pulled toward the seat just as was the cardboard. At the same time, the radial steam jet raises the pressure in D by recompression, snapping the disc down on the seat.

Downward force of recompressed steam in D, acting on the full area of the disc, is greater than the upward force of the inlet steam acting on the smaller area of the inlet orifice. So the disc remains seated, stopping all flow of steam, until pressure in D is reduced by condensation, and the cycle is repeated.

BEYOND THE TD-50 PRINCIPLE

Surprise! In spite of the one-track subject matter you've had the decency to ingest so far, we manufacture a good deal more than TD-50's. As a matter of proud fact, we are the only company that makes and sells all five types of steam traps. After all, there is a place for Balanced Pressure Thermostatic, Float Thermostatic, Camlift Bucket, and Liquid Expansion Thermostatic Steam Traps too. And our knowledgeable engineers can tell you exactly where to use what—and how.

And may we modestly add, that's only the beginning? As long as our present conversation seems to consist of product name dropping, we'll just mention the fact that we make exceptionally fine pressure and temperature regulators of rather astonishing variety and ingenuity. For example, we have a complete line of self-powered regulators for heating and cooling. And to make most effective use of these last few lines—strainers of all kinds—even hand and motor operated scraper strainer types. We could fill this page with lists of applications, testimonials, and specifications, but it would be eminently more sensible simply to say: Tell us your problem. Write us direct, or contact your local Sarco sales representative or sales office.

Pardon our monopolizing the conversation in this series of paid communiques, but we're trying our best to interest you in certain subjects that concern us both—to the point where you'll communicate.

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Conference on New Trends in Chemistry (continued) . . .



H. F. MARK AND S. M. ATLAS: High Polymers—One of the prime objects of current polymer research is the synthesis of materials that can sustain at least 900 F. for long periods. The paper will examine the latest techniques for incorporating elements such as Be, Mg, Al, Si, P, Sn or Ti, in organic polymers. Capacity to make stereoregulated polymers has been considerably improved, both in degree of stereoregulation and yields, by closely controlled conditions in preparing certain Ziegler-Natta catalysts. Special combinations of titanium subhalides and aluminum alkyls have produced polypropylene with up to 95% isotacticity. Some hydrocarbon monomers, such as vinyl halides, acrylates and methacrylates have been obtained in stereoregulated versions, and it is probable that catalysts will be found that will allow regulation of all such polymers.

Dr. Mark (top photo), formerly director of the Polymer Research Institute, is now dean of the faculty of Polytechnic Institute of Brooklyn. Dr. Atlas (below) is head of the Chemistry Dept. at Bronx Community College.



A. E. MARTELL: Metal Complexes in Aqueous Solution—Principles of complex formation will be used to show how the properties of metal ions may be modified via reaction with various types of complexing agents. New equilibrium data will be employed to predict quantitatively the use of complexes to modify tendencies of metal ions to precipitate, hydrolyze and undergo redox reactions.

Professor Martell is chairman of the chemistry department at Illinois Institute of Technology.



H. A. POHL: Organic Semiconductors—Organic semiconductors—for which there are many potential industrial uses—draw upon techniques of four scientific disciplines: physics, organic chemistry, polymer chemistry and biology. This paper shows that study of these materials involves the fundamental laws of quantum mechanics plus the insight of the organic chemist.

Dr. Pohl heads a research group at Princeton's plastics laboratory.



F. V. SCHOSSBERGER: Solid-State Chemistry—A brief discussion of solid-state theory of semiconductors is followed by examples of various crystallization phenomena and their relation to crystal defects. Examples include impurity defects in germanium luminescence phenomena, chalking of outdoor paints, action of pour-point depressants in oil, and preparation of large semiconductor crystals.

Dr. Schossberger is assistant director of chemical research at Armour Research Foundation.



R. J. TYKODI: Chemical Thermodynamics—A new offshoot of thermodynamics, the science of the irreversible process, will be taken up in detail. Some simple techniques for handling nonequilibrium situations involving stationary states and steady-rate processes will be discussed and, by way of illustration, both the thermomolecular pressure effect and forced vaporization of liquids will be considered.

Dr. Tykodi is assistant professor of chemistry at Pennsylvania State University.



R. H. WENTORF, JR.: High-Pressure Chemistry—Although energies imparted by pressures of 100,000 atm. are small compared with chemical bonding energies, such pressures are sufficient to shift many equilibria or perturb outer electron structures of atoms. During the past few years, many techniques have been developed to study effects of pressure in this range and higher.

Dr. Wentorf is a physical chemist in General Electric's Mechanical Investigations Section (which produced the first man-made diamonds).

The Conference on New Trends In Chemistry

Watch for additional details about conference pre-registration and hotel reservations in an upcoming issue of *Chemical Engineering*. Remember the date: Oct. 11-12. The place: the Sheraton-Chicago Hotel, Chicago, Ill.

Adapting Old Methods Can Cut Cost of New Plants

Cost-reduction tools, such as industrial engineering, are fully utilized by manufacturing industries, but are usually ignored in plant construction. According to Procter & Gamble's R. J. Short, however, these techniques can substantially reduce both construction time and capital investment for new plants. In a paper delivered before the Building Research Institute, Short noted that P&G has erected better and lower-cost plants by adapting manufacturing-type cost-control

methods to construction projects.

For every two supervisors, an operating plant will average one staff assistant whose sole function is cost reduction (usually using industrial engineering methods); and he pays off his cost four times over, claims Short.

The industrial engineer's cost-cutting tools are also available to plant builders, but they are seldom, if ever, used on a construction site, even though a comparison of the *Engineering News-Record* construction index with the cost indexes of other industries shows that construction costs have the greatest rate of increase. Also, a dollar saved in manufacturing costs nets

only 50¢ profit after taxes; but a dollar saved in construction is returned intact to the company treasury, since building is done with after-tax dollars.

One of the major areas for construction savings, Short believes, is the use of preassembled plant components. However, this concept can only be properly utilized as part of an aggressive over-all program of cost reduction.

In P&G's experience, use of pre-assembled components has contributed significantly to savings in plant investment costs, although these components did not contribute as much to savings in operation and maintenance as some had expected.

PHTHALIC ANHYDRIDE



New fluid-bed process offered by Foster Wheeler

Foster Wheeler is the exclusive licensor of a new fluid-bed process specifically designed to utilize the UCC (United Coke & Chemical, Ltd.) catalyst for phthalic anhydride production.

In over three years commercial operation this process has provided long *uninterrupted* runs . . . *consistently* high yields . . . *assured* operation at rated capacity . . . and long catalyst life without reactivation. The entire operation has been virtually trouble-free.

Currently, one of the world's largest phthalic anhydride plants is being constructed using this unique fluid-bed process.

If you are considering an increase in phthalic anhydride production, it will profit you to discuss your requirements with Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, New York.

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Plants

National Petro Chemicals Corp. has been set up by National Distillers and Chemical Corp., New York, and Owens-Illinois Glass Co., Toledo, Ohio, to operate the firms' joint 60-million-lb./yr. linear polyethylene plant now under construction at Houston. A major market for linear polyethylene is blow-molded bottles for detergents and other household wares, a market that Owens-Illinois was instrumental in developing. Houston facility is due on stream late next year.

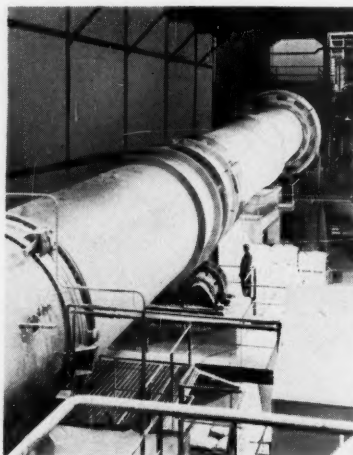
Consolidated Edison Co.'s \$22-million nuclear core for the power station now under construction at Indian Point, N. Y., has achieved its first sustained chain reaction. The criticality test was held in the laboratories of the core's fabricator, Babcock & Wilcox Co.'s Atomic Energy Div. Fuel is a mixture of thorium and uranium oxides, designed to deliver 275,000 kw. to the New York city area for two years without refueling.

Cary Chemicals, Inc., East Brunswick, N. J., plans a \$14-million corporate expansion. Items: (1) a 100-million-lb./yr. plant in New Jersey, to make polyvinyl chloride copolymers by the fall of 1962; (2) similar plant somewhere in the Midwest, but with only half the capacity. Cary now makes 50 million lb./yr. of vinyl polymers and copolymers at Flemington, N. J., and 36 million lb./yr. at East Brunswick, N. J. For details of the firm's complex "production and marketing association" with Tennessee Gas Transmission Co., see *Chem. Eng.*, Mar. 6, p. 151.

Copolymer Rubber & Chemical Corp.'s \$5-million butadiene plant is on stream at Baton Rouge, La., the second facility in the nation to use Dow Chemical Corp.'s catalytic route to the SBR rubber ingredient. Copolymer's original butadiene installation was expanded and revamped to take the new Dow process, boosting the

local Baton Rouge firm's SBR capacity to 133,000 long tons/yr. (up from 95,000 long tons/yr.).

Great Lakes Steel, a division of National Steel Corp., plans to have its basic-oxygen steel facilities at Detroit under full computer control by early next year. TRW Computers Co., a division of Thompson Ramo Wooldridge Inc., will install the system.



The New Jersey Zinc Co. has completed a 100% expansion of its titanium dioxide plant in Gloucester City, N. J. Giant 175-ft.-long rotary calciner (above) boosts output to 48,000 tons/yr.

National Bureau of Standards has broken ground for its \$104-million research laboratories at Gaithersburg, Md. Complete relocation of the Bureau will take place during 1963-65, as the 555-acre site's 20 buildings are completed one by one.

DX Sunray Oil Co. has placed a \$1-million Hydeal unit on stream at its Tulsa, Okla., refinery. Design capacity is 1,000 bbl./day of benzene, but currently only 800 bbl. are being turned out. Charge stock is toluene, produced in an adjoining Udex unit constructed last year.

Coastal Chemical Co. plans a \$4.5-million expansion of its Pascagoula, Miss., facilities. Nitrogen capacity will be doubled, to 400

tons/day. Last year, Coastal's 10-year-old parent firm, Mississippi Chemical Corp., returned patronage refunds of \$5 million to its 10,000 farmer-owners.

Du Pont plans to double the 30-million-lb./yr. capacity for polyethylene film at its Spruance complex in Richmond, Va. Construction begins immediately, with completion scheduled for about a year from now.

The Colorado Fuel and Iron Corp. has tapped the first heat of steel from its expanded basic-oxygen steel facilities in Pueblo, Colo. Representing a major portion of the firm's current \$21-million modernization program, the plant can now turn out 100 tons/hr. of molten metal. Linde Co. recently placed on stream at the site a 280-ton/day oxygen unit (*Chem. Eng.*, July 10, p. 174).

Olin Mathieson Chemical Corp. plans a multimillion-dollar expansion of its Omal, Ohio, aluminum rolling mill. Due for completion by the end of 1962, new facilities will "greatly" increase Olin's capacity for bright aluminum sheet, due largely to the addition of a 66-in.-wide cold-rolling mill. Primary aluminum comes from Ormet Corp., a joint subsidiary of Olin with Revere Copper and Brass, Inc.

Stauffer Chemical Co. has begun constructing a multimillion-dollar captive chlorine plant at Dominguez, Calif. Total output will be pipelined to American Chemical Corp., a joint subsidiary of Stauffer with Richfield Oil Co., as a raw material for vinyl and ethylene chlorides. Unit is due on stream by the third quarter of next year.

Allied Chemical Corp.'s General Chemical Div. plans to build its first commercial Aclar and Capran film plant near Pottsville, Pa. Currently in pilot-plant produc-

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CPI News Briefs

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Polyvinyl fluoride film

Film resists weather, can protect other materials from the elements.

Marketed under the name of Tedlar, Du Pont's new polyvinyl fluoride film finds its best selling point is its weatherability.

It can either pass or reflect ultraviolet rays, depending on whether it is pigmented or not, without being destroyed itself. After seven years in the Florida sun, for example, Tedlar retained 50% of its tensile strength and 25% of its bursting strength. On the basis of such exposure tests, it's predicted that under similar conditions, 2-mil Tedlar would last four times as long as 2-mil Mylar W (a Du Pont polyester).

Currently sold in development quantities at \$5/lb., Tedlar is expected to drop in price as soon as Du Pont's PVF plant at Buffalo, N. Y., goes on stream in mid-1962.

Marketers hope to find applications for the film in protective and decorative finishes laminated to metal or wooden structural materials, glazing materials and flexible roofing. Or they may be able to sell PVF film for packaging applications, touting Tedlar's chemical resistance and low gas permeability.—E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. 80A

Anticorrosion coatings

Epoxy resins are now used as binders in zinc primers.

Zinc-rich primers have been well known for their speed of application and for the protection they give to metals. A 10-20 micron coating, for example, dries in a few minutes and wards off rusting of steel for at least a year—even when steel is stored outdoors in all sorts of weather.

But at the recent Achema meeting in Frankfurt, Germany, P. H. Enthoven of Shell Plastics Laboratory pointed out to *CE* editors that most zinc-rich primer coatings don't satisfactorily resist salt water, and may soften if subse-

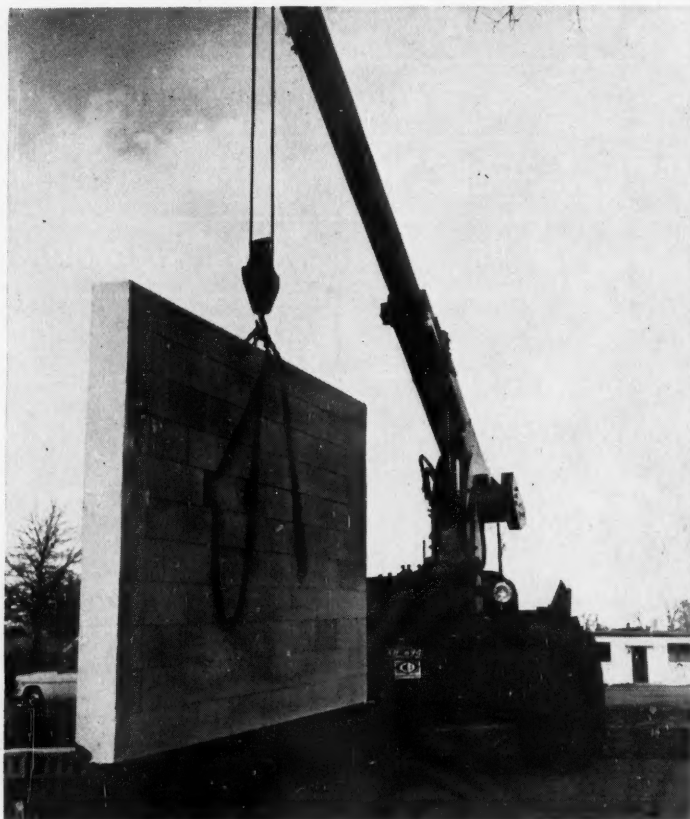
quent overcoat paints contain sharp solvents.

According to Enthoven, both problems can be eliminated with zinc primers that use epoxy resins as the binder material. By cross-linking in three dimensions, this epoxy binder will make a tough bond between the zinc pri-

mer and the steel. After cure, the film can be overcoated with any other surface coating system, without danger of softening by solvents, or loss of adhesion.

Recently developed primer coatings contain about 94% by weight of ultrafine zinc dust and 6% of binder, which consists of Epikote

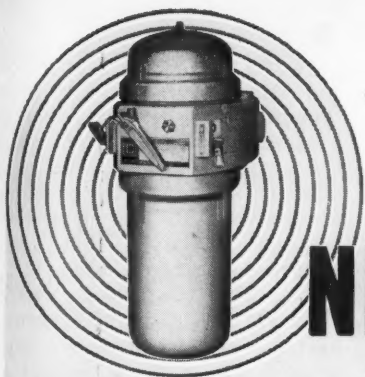
Quakeproof wall is possible with epoxy mortar



A wall panel, made of concrete blocks bonded by Threadline Mortar, held successfully even after it was lifted; subsequently laid down, picked up and jostled by the crane's boom, trying to break the wall joints.

The new mortar consists of epoxy resins and mortar ingredients that when combined make an adhesive suitable for bonding concrete, cinder, lightweight blocks and bricks. Easily applied by extruder, caulking gun or similar tools, Threadline cuts the time and labor required in masonry works in half. At 70 F., it reaches an initial cure in 24 hours and full strength in 72 hours—nine times faster than ordinary mortar.

According to the manufacturer, a 50-lb. Threadline kit is sufficient to lay 500 masonry blocks. To do the same job with ordinary mortar, one would need six bags of cement, three bags of lime, 150 shovels of sand and 25 gal. of water—a weight of 1,500 lb.—Raybestos-Manhattan Inc., Bridgeport, Conn. 80B

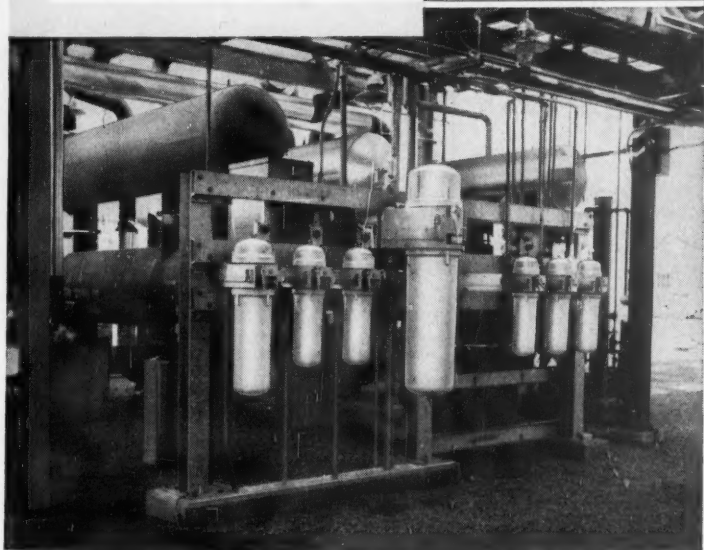


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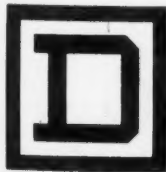
...you now can order Square D Spin Top enclosed starters completely wired and mounted on racks built to your specifications. Or, working through our field organization, we'll help you or your engineers design the rack. Either way, all the wiring and assembly work is done at the factory. Rack framework can be either bolted and hot-dipped galvanized or welded and painted.



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Spin Top enclosures are available in four sizes to include circuit breakers, across-the-line starters and combination starters, Size 0 through 5, reversing, non-reversing, and two-speed versions. They're built for Class I, Group C and D; and Class II, Group E, F, and G service.

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1001 (an epoxy resin) and a polyamide resin as curing agent.

In the Rotterdam, Netherlands, shipyards, the steel treated with the new primers is mechanically handled, welded, cut and bent without damage to the zinc coating. Prefabricated sections have been stored outdoors and the hull on the slipway further exposed to weathering and salt water for over a year without rusting; the surface remains in such good condition that overcoating can be effected without elaborate cleaning.—Shell Plastics Laboratory, Delft, Holland. 80C

Catalyst

Product offers high activity and long service life in sulfuric plants.

Designed to boost the conversion efficiency of SO_2 to SO_3 , Code 816 catalyst is finding good acceptance in contact sulfuric acid plants, which until recently have used only platinum or vanadium catalysts.

Although the exact nature of the catalyst is still a secret, the new material is reported much more active than the usual vanadium catalysts. According to D. B. Burkhardt, president of Von Bree Inc., Code 816 pellets need only one fourth the depth at 450 C. and only one-tenth the depth at 550 C. to get the same change in conversion as with a unit depth of vanadium.

Because of its high cost (\$20/liter, with a salvage value of \$9/liter on replaced material), the new catalyst is used in the 350-470 C. range where vanadium is relatively inert. Or it is employed in thin layers in combination with existing vanadium catalyst to yield higher production rates than are possible with vanadium alone.

Sold in the form of 3-in. by 3-in. pellets, the new product has a kindling temperature of 350-370 C. under plant conditions with 9-10% SO_2 feed gas. Kindling point increases about 5-10 C. per year; pellets do not spall in service, can be used up to 700 C., and have a useful life of over six years.

Because of the larger pellet size, pressure drop per unit depth is reported to be only 20% that of the usual vanadium catalyst. Much-lower pressure drops (alternately, greater gas flow) can be obtained by partial replacement of vanadium because of the lesser depth of Code 812 needed per unit of conversion change.—Von Bree Inc., Newark, Del. 82A

Ferrocene

Organometallic is now available in development quantities.

Dicyclopentadienyl iron is the latest addition to the series of transition-metal organometallics produced by Ethyl Corp. Commonly known as ferrocene, the compound is being offered in development quantities at \$10/lb. However, Ethyl is looking forward to the time when production of ferrocene will be in the million pound range and prices will be between \$2 and \$4/lb.

Because of its unique, stable structure, ferrocene is expected to find applications in areas that include: combustion control additives, high-temperature lubricants, intermediates for thermally stable and radiation-resistant polymers and ultraviolet absorbers.

An orange-yellow crystalline powder at room temperature, pure ferrocene, $(\text{C}_5\text{H}_5)_2\text{Fe}$, is a sand-

wich structure comprised of two cyclopentadienyl rings lying in parallel planes with an iron atom located between them. The metal atom is symmetrically bound to the five carbon atoms of each cyclopentadienyl ring.

Pure ferrocene melts at 173 C., boils at 249 C., and resists pyrolysis at 470 C. It is soluble in a number of organic solvents including benzene (19 g./100 g. solvent at 25 C.).

The ferrocene marketed by Ethyl assays 98 wt.% dicyclopentadienyl iron, and melts in the 172-175 C. range.—Ethyl Corp., New York. 82B

Masonry waterproofing

Boron esters bind silicon esters to calcium in masonry pores.

Three years of research have resulted in a sophisticated approach to waterproofing masonry products with silicon. By combining the effects of boron and silicon, Guardian Chemical Corp. has developed a waterproofing agent that binds itself into place. Called Surtiseal, the agent contains boron and silicon esters in an aqueous base, can be applied to wet concrete, damp basement walls, or even mixed directly with concrete.

Acting as a chemical link, the boron ester binds the silicon ester to the calcium in the masonry,

—Newsworthy chemicals—

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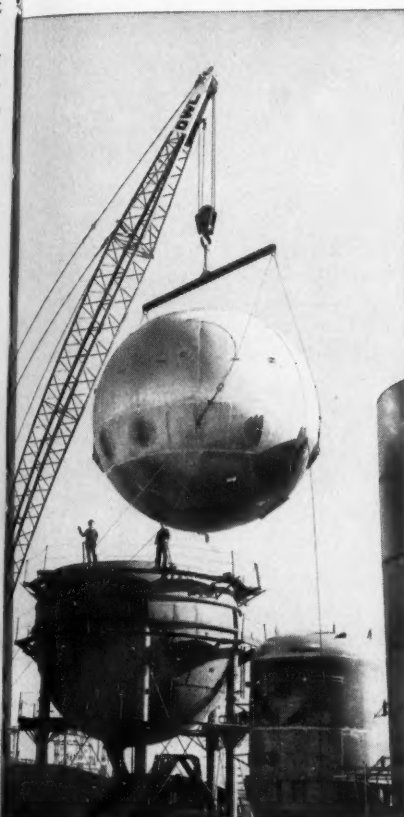
Polyvinyl fluoride film protects materials from weather.....	80A
Epoxy mortar makes quakeproof walls.....	80B
Zinc-epoxy primer: new weapon against steel corrosion.....	80C
New catalyst outperforms vanadium in SO_2 to SO_3 conversions.....	82A
Dicyclopentadienyl iron enters organometallics market.....	82B
Boron and silicon esters team up in waterproofing masonry.....	82C
Aleuritic acid goes commercial.....	84A
Platinum reforming catalyst has no halide content.....	84B
New stripping agents remove organic coatings from metals.....	84C
Antirust agent replaces wire-brushing and blast cleaning.....	84D
Polyethylene gets highest density (0.962) from new process.....	84E
Di-2-ethylhexyl azelate improves vinyls' performance at low T.....	84F
New catalyst is effective for anhydride systems.....	84G
High-purity triethylene glycol is now available.....	84H
Fatty amide lubricates polyethylene and polypropylene films.....	84J
Phosphate buffer is antidote for chemical burns.....	84K

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-320°F



These double-wall cryogenic storage tanks play a vital role in the first privately-owned plant to supply liquid hydrogen on a large-scale commercial basis. Hydrogen is stored in the sphere at -423°F and nitrogen in the cylindrical tank at -320°F. Located in Torrance, Calif. and owned by Linde Company, Division of Union Carbide Corporation, the plant will deliver 3,300,000 lbs. of liquid hydrogen yearly to missile centers. Both tanks were designed (using Linde-approved designs), fabricated and erected by CB&I, world's most experienced builder of cryogenic vessels.



ABOVE: Aluminum inner shells and carbon steel outer shells were used for the two cryogenic tanks. The spherical tank is 28 ft. in diameter and the cylindrical tank 21½ ft. Special insulation is between the shells.

TOP LEFT: The inner sphere is suspended in the outer sphere by stainless steel rods positioned around the perimeter. Resting on the ground nearby is the aluminum inner shell of the cylindrical nitrogen tank.

LEFT: A trailer is being loaded with liquid hydrogen for delivery to missile centers, other government installations, or industry.

CB&I

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imparting long-life water seepage protection to the treated surface. If correctly applied, two coats of Surtiseal can prevent substantial water permeation for five to ten years, according to the manufacturer.

Treated surfaces can be painted. When unpainted, the appearance of the treated area is enhanced by a built-in masonry brightener. However, brightener life is relatively short—about one year.

Already available in commercial quantities, Surtiseal can be used to protect concrete sidewalks and highways against the chemical action of de-icing salts. —Guardian Chemical Corp., Long Island City, N. Y. 82C

Aleuritic acid

Compound is an intermediate in manufacture of plastics, adhesives, pharmaceuticals and perfumes.

Aleuritic acid, chemically $\text{OH} \cdot \text{CH}_2(\text{CH}_2)_2(\text{CH} \cdot \text{OH})_2(\text{CH}_2)_2\text{CO}_2\text{H}$, is a slightly yellow solid that melts at 101 C., weighs about 4 lb./gal., and is practically unknown—except to French perfume makers who pay as much as \$4/g. for it.

But now, through the joint efforts of New York's William Zinsser & Co. and Angelo Bros. Ltd. of Calcutta, India, aleuritic acid is produced in commercial quantities, sells at \$5.75/lb., and can branch out in even industrially larger markets.

Extracted from shellac, this acid serves as a versatile chemical intermediate because of the position of its reactive hydroxyl and carboxyl groups. Catalyzed with mineral acids, it reacts with alcohols, giving esters that are useful in compounding with cellulose esters for making lacquers, plastics and fibers.

Condensation of aleuritic acid with phthalic anhydride and glycerin yields a clear product of good adhesive properties. Using the acyloin synthesis, one can obtain α,ω -dicarboxylic acids and ω -hydroxy acids.

Aleuritic acid is soluble in

lower alcohols, such as methyl, ethyl and isopropyl, also in dioxane, glycerin and lower glycols. —William Zinsser & Co., New York. 84A

Briefs

Platinum reforming catalyst, now offered in a halide-free form, can produce high yields of motor gasoline of desired high octane number, at relatively mild operating conditions and without addition of halogen compounds to the feed. The new catalyst is readily regenerated *in situ* for restoration of activity after prolonged use. —Houdry Process Corp., Philadelphia. 84B

Five stripping agents have been prepared for removal of protective coatings from various metals. These new formulations boast such features as increased efficiency with a reduction of caustic, fast stripping rates, stability at both room and elevated temperatures. They are particularly effective in stripping phenolics, epoxies, urea and melamine formaldehyde, varnishes and coatings based on drying oils. —Armour Industrial Chemical Co., Chicago. 84C

Rust remover Aci-Gel, composed of several acids that clean metals by chemical action, claims to replace costly manual methods such as wire-brushing, blast cleaning and flame cleaning. Suspended in a thixotropic gelling agent, product clings to vertical surfaces and won't sag. It acts in minutes and, after flushing with water, leaves a clean surface ready for painting. —Sloan Chemicals Inc., Cleveland. 84D

Highest-density polyethylene is claimed by Hi-fax resins, made by a proprietary Hercules process via Ziegler catalysts. Density is 0.962 (compared to 0.945 for the original Hi-fax high-density polyethylene). —Hercules Powder Co., Wilmington, Del. 84E

Di-2-ethynexyl azelate, designated Flexol Z-88, can be used as the sole plasticizer for vinyl applications that demand good low-temperature performance. Because of this plasticizer's low volatility, vinyls can maintain their properties over extended periods of time with improvement in the drape and softness of films, sheeting and coated fabrics. —Union Carbide Chemicals Co., New York. 84F

Anhydride systems catalyst is said greatly to prolong pot life, to give sharper cures, to maintain low viscosity and to raise heat qualities of all anhydride resins. Dubbed Catalyst 215X, the accelerator is particularly effective in curing methyl nadic anhydride, but operates well in any anhydride system with 2.5-5% resin. —Isochem Resins Co., Providence, R. I. 84G

Triethylene glycol, recently cleared by the Food and Drug Administration for use in food packaging, is available in a premium grade of less than 0.1% diethylene glycol impurity. Applications range from a plasticizer or humectant in cellulosic food wrappers to cork seals for beverages. —Dow Chemical Co., Midland, Mich. 84H

Fatty amide named Kemstrene Su is a dry, free-flowing powder aimed at introducing improved slip and antiblock properties to polyethylene and polypropylene films. Other oleamides are waxy, of gum-like consistencies. —HumKo Products' Chemical Div., Clifton, N. J. 84J

Phosphate buffer called Neutralize is an antidote for acid, alkali, hydrazine and other burns; it washes fuming chemicals from the skin and eyes in a fraction of the time needed by water. —E. D. Bullard Co., Sausalito, Calif. 84K

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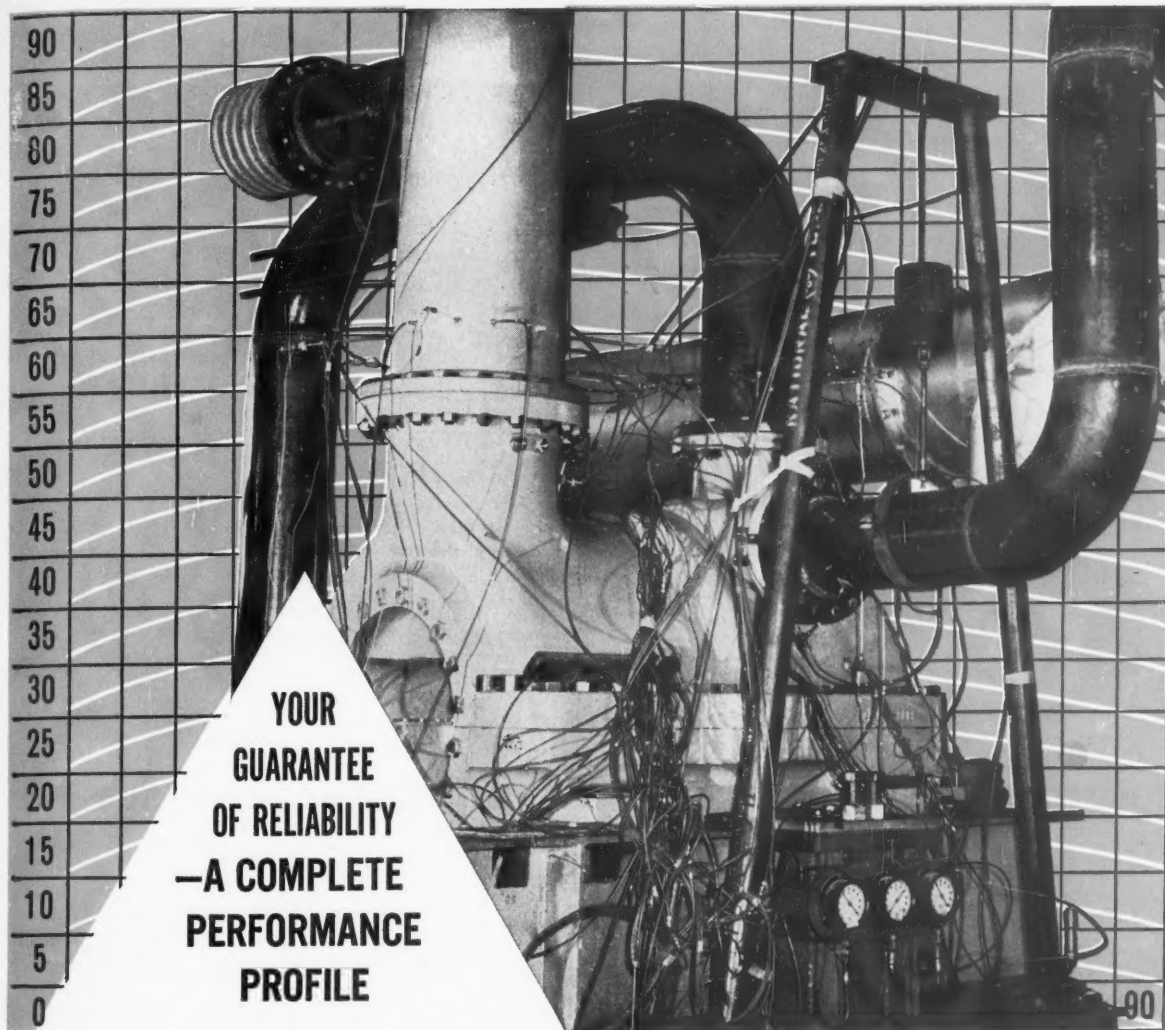
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JOY DYNAMIC COMPRESSORS

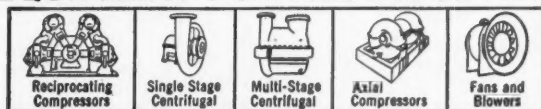
Joy testing procedure gives a complete performance profile of every dynamic compressor manufactured. Costly process shutdowns can be avoided, because critical performance data under various inlet and discharge conditions are known from actual tests. Temperature and pressure readings are taken at ten different points on each compressor under eight sets of conditions.

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mands for higher efficiency, fewer stages, space and weight limitations, or special seals, Joy engineers are prepared to evaluate and design compressors to fit your particular needs.

Joy offers dynamic compressors in sizes from 15 to 15,000 hp, as well as a line of reciprocating compressors from 15 to 1250 hp. Consult your Joy representative whenever you need machinery for compressing air or gases. For further information on Joy Dynamic Compressors, write for Bulletin 2563-11.

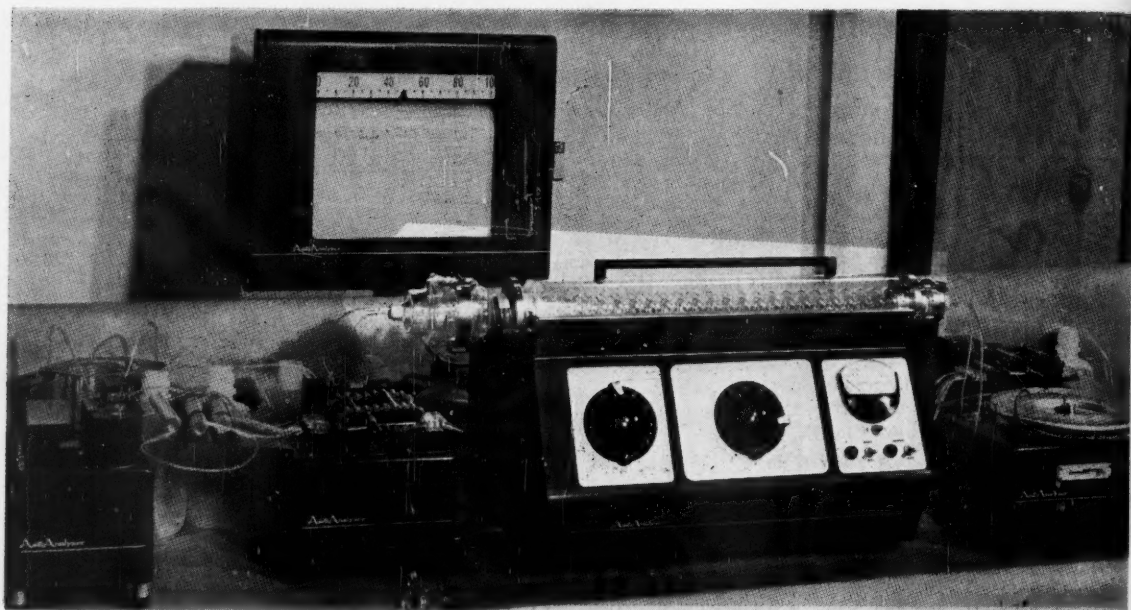
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Key to automatic nitrogen analysis is a continuous digester (highlighted) that cleans itself between samples.

AUTOMATIC DIGESTER SPEEDS NITROGEN ANALYSES

Where nitrogen content is related to a variable in a batch or continuous process, automatic monitoring can provide analysis and control on a highly reproducible basis. The system is many times faster than the classical Kjeldahl method

Automatic process control is no better than the system that determines the need for a change of conditions, which in many cases depends in turn on analysis of the stream.

Where the quality of the stream can be related to a nitrogen analysis, a new device developed by Technicon Controls, Inc. can provide speedy, reproducible results that can be converted into a control signal. The unit also can be used in the laboratory for a many-fold increase in nitrogen analyses.

Areas of the process industries where the instrument may prove important include:

Pharmaceutical—nitrogen determination helps identify and establish purity of organic compounds in many cases where a specific analysis does not exist.

Fertilizer—analysis of raw materials and final product is needed to assure that nitrogen content is equal to (but not significantly greater than) the label value.

Feed and Milling—protein content, determined by nitrogen analysis, is critical in both raw materials and final product. Protein content is guaranteed in feeds such as corn gluten feed and meal.

Food and Fermentation—Many foods are sold on the basis of protein content, hence nitrogen analysis of products is imperative. Likewise, yeasts, alcoholic beverages and antibiotics need nitrogen analysis for raw materials, intermediate or final products.

Petroleum and Chemical—wherever nitrogen content of a stream can be related to a controllable process variable, the automatic analyzer may be used.

► **What Is It?**—The automatic sys-

tem includes a number of standard components, with the important addition of a new digestion vessel that can accept a series of samples and prepare them for quantitative analysis.

Basically, the digester consists of a glass tube containing a helical groove along its 2-ft. length. As the tube is rotated, material introduced at one end is conveyed to the other.

At the start, only the digestion fluid is flowing through the helix. After the sample is added, the mixture occupies a certain number of grooves. Additional digesting fluid cleans the helix between specimens and forms a barrier between them so the identity of each individual sample is preserved throughout the system.

Digestion takes place in two stages. In the first, the sample mixture is oxidized at about 450 C.; in the second, at 350 C., digestion is completed. At the exit end, digested samples follow each other into a trough, where an aspirating pipette continuously draws off an

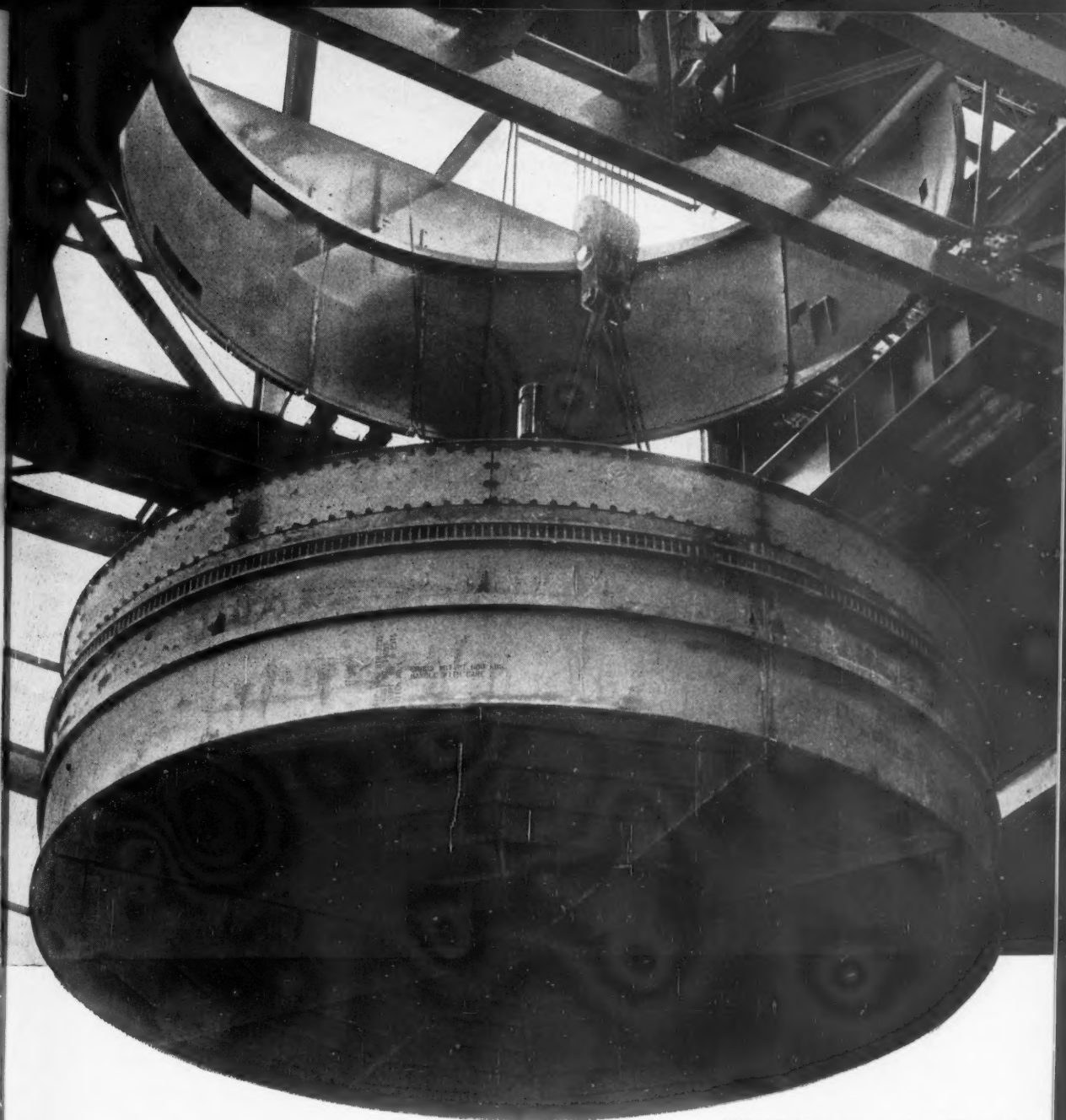
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DOW RECOVERS 425°F WITH LJUNGSTROM® AIR PREHEATER

When Dow Chemical Company's Westside Power House at Midland, Mich., starts up their new 650,000 lb/hr boiler, more than half the waste heat will be *recovered* by a Ljungstrom Air Preheater. Dow's newest Ljungstrom (this is the eighth in their system) was designed to lower stack gas temperature from 700°F to 275°F, thus *recovering 425°F*. As a direct result,

company engineers expect at least 10% reduction in fuel costs.

On process stills or boilers—or wherever large volumes of heat are involved—Ljungstrom Air Preheaters improve combustion, make fuel burn more completely. It's possible to save as much as 20% on fuel. **All major public utilities** use Ljungstroms; as do many major chemical and petroleum processing

This 25' Ljungstrom rotor will contain a total heating surface of 128,000 sq ft. Continuous heat recovery by this unit will boost the temperature of incoming combustion air from 100°F to 585°F. Every 45-50°F thus returned as preheat increases boiler efficiency about 1%.

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CORPORATION**

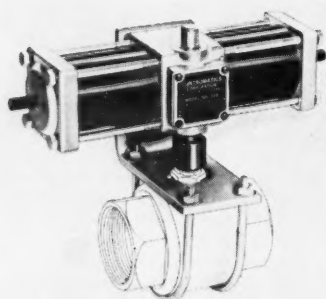
60 East 42nd Street, New York 17, N.Y.

aliquot for analysis in an Auto-Analyzer system.

► **Permanent Record**—When the sample has passed through the analyzer, where it has been converted by various reagents to a form suitable for colorimeter analysis, the result is permanently recorded on a strip chart. This reading can be converted into a control signal if the system is used for process analysis. It can also be related to a particular batch or portion of a batch by the time parameter on the chart.

Proper flow of reagents and samples is maintained with a proportioning pump that consists of a series of flexible tubes that are progressively compressed by a number of rollers. The rollers pass along the tubes at the same rate, so by varying tube diameters, flow ratios can be accurately maintained.

Other advantages of the automatic system are savings in equipment space requirements ($\frac{1}{4}$ of that required for manual analysis by the classical Kjeldahl method), and considerable reduction in glassware inventory since the automatic system is self cleaning.—**Technicon Controls, Inc., Chauncey, N. Y.** 86A



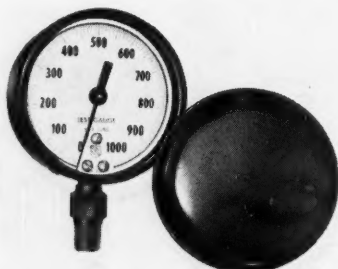
Valve actuator

Pneumatic unit is adaptable to ball, plug, butterfly valves.

A remotely controlled pneumatic valve actuator can be installed on quarter-turn valves of any type, make or size. Four models span the torque range from 100 to 2,050 in. lb.

Self-contained with no external actuating levers or swiveling cylinders, the unit is lubricated and sealed at the factory. In tests, models have operated for more than 250,000 cycles at rated torque, according to the manufacturer.

Close-coupled construction and central mounting results in minimum space requirements when device is installed.—**Contromatics Corp., Rockville, Conn.** 88A



Test gage

Pressure-vacuum instrument ranges from 30 in. Hg vacuum to 300 psi.

Accurate to within 0.5% of scale range, this test gage is now available in compound as well as regular pressure ranges. Dial is graduated over 330 deg. of arc to give wider calibration subdivisions than are available on conventional gages.

Suitable for use with air, steam, liquids or gases that are noncorrosive to phosphor bronze, the unit has a beveled, extra-thick glass dial-cover to reduce parallax in readings. If desired, the gage is furnished for oxygen service. A protective cover is optional.

Four units cover the following ranges: vacuum to 30 or 300 psi., 0.30 or 0-1,000 psi.—**Manning, Maxwell & Moore, Inc., Stratford, Conn.** 88B

Gas detector

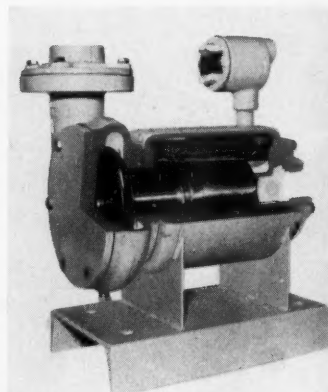
Diffusion sampling is used to find combustible gases and vapors.

Said to cost less than permanently installed sample-drawing

instruments, a diffusion-head-type gas detector and alarm unit continuously monitors hazardous areas, reports the presence of natural gas, LPG and other combustible gases and vapors.

The head containing the detector filament is connected to the analyzer by three wires enclosed in a small conduit. Atmospheric currents reach the filament through a screen that prevents ignition of explosive fumes.

The analyzer unit should be located in a gas-free area in its dustproof aluminum case, although an explosionproof housing is available. A transistor-regulated power supply yields constant voltage to the filament despite line variations. — **Johnson-Williams, Inc., Palo Alto, Calif.** 88C



Canned pump

Sealless unit delivers up to 100 gpm. at 92 ft. head.

Rated to 500 F., a high-head, high-capacity pump has only one moving part—the rotor-impeller. Like other canned units, there is no seal, stuffing box or lubrication fittings.

Pump design provides that all bearings are fully flushed with the pumped liquid without the need for a recirculating tube to insure lubrication of the rear bearings. For cleaning or bearing replacement, the volute plate can be removed without disturbing the piping. The rotor-impeller shaft



CRYSTOLON

Now...a low-cost Nitride-Bonded Silicon Carbide!

“63”

Now, the best-performing silicon carbide refractory is available at a realistic price! Brand-new CRYSTOLON “63” permits the use of a cost-saving nitride-bonded silicon carbide refractory for hundreds of applications.

Produced by an exclusive Norton process, CRYSTOLON “63” silicon carbide provides all the superior properties of nitride-bonded silicon carbide at a *new low cost!* It has high thermal conductivity, excellent heat shock and wear resistance, and good resistance to most corrosive liquids. In extensive tests, it not only showed excellent resistance to “wetting” by molten non-ferrous metals (aluminum, magnesium, zinc, lead and others) but also to fused salts, such as cryolite!

Use CRYSTOLON “63” silicon carbide as a refractory for handling corrosive salts — as reactor lining — as the *economical* solution to hundreds of tough processing problems. Get complete test results and properties now. Write NORTON COMPANY, Refractories Division, 508 New Bond Street, Worcester 6, Mass.

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CHEMICAL ENGINEERING—August 21, 1961

assembly slides out through the same opening.

The unit is available in cast iron or Type 316 stainless steel, for pumping a variety of fluids including corrosives or process fluids that may not be contaminated by lubricants or packing.—**The Corley Co., Boonton, N.J.** 88D



Conductivity meter

Portable or panel mounted, it reads concentrations of varied solutions

Concentration of solutions ranging from distilled and demineralized water to concentrated acids and bases can be measured with this conductivity meter. Scale can be provided with micromho calibrations, as well as direct reading in terms of solution concentrations being measured.

Output terminals are provided for connection to a standard millivolt recorder or controller. Manual or automatic temperature compensation can be provided. Used with suitable conductivity cells, the meter serves as a portable unit or may be panel mounted.—**Industrial Instruments, Inc., Cedar Grove, N. J.** 90A

Solids pump

Pneumatic unit unloads pulverized materials from railroad cars.

A fluidized-solids pump unloads materials from hopper-bottom railroad cars to storage bins or trucks. It is said to handle a wide range

of pulverized materials, such as portland cement, limestone, clay and similarly sized solids.

Called the F-K 62, the unit requires a trench only 17-in. deep below the bottom of the rail. Pump and air supply are combined in one package, available with either V-belt or direct drive.

Transfer rate is up to 300 bbl./hr. of portland cement at distances up to 125 ft. Single-stage, positive displacement blowers are said to keep investment for power and air requirements to a minimum.—**Fuller Co., Catasauqua, Pa.** 90B



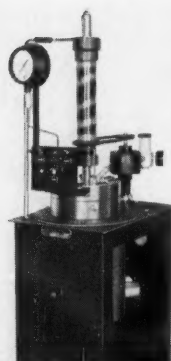
Vertical tank heater

Aluminum fins on 1-in. pipe give 244 sq. ft. of heating surface

Wound into a helix that is 19½ in. in dia., a length of 1-in., finned steel pipe is supported on three legs to form a portable tank heater that fits through a standard 20-in. manhole and gives 244 sq. ft. of heating surface.

The legs permit free thermal expansion of the coil, and position the heater above normal sludge level in the tank. The 165-lb. unit has only one weld, does not need stress relieving. — **The Griscom-Russell Co., Massillon, Ohio.** 90C

For more information about any item in this department, circle its code number on the Reader Service Postcard (Page 185)

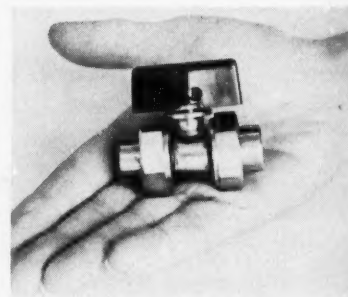


Stirred autoclave

Magnetically agitated, unit has no packing or stuffing box for shaft.

For high-pressure work, this stirred autoclave offers rotary agitation of contents without stuffing box or packing. External magnets drive internal magnets attached to the rotor shaft, which is completely sealed in the autoclave.

The design eliminates leakage, lubricants, shaft-cooling equipment, frictional wear on the shaft, and packing replacement costs.—**Autoclave Engineers, Inc., Erie, Pa.** 90D



Ball valve

Unit is used for sampling, instrumentation and metering.

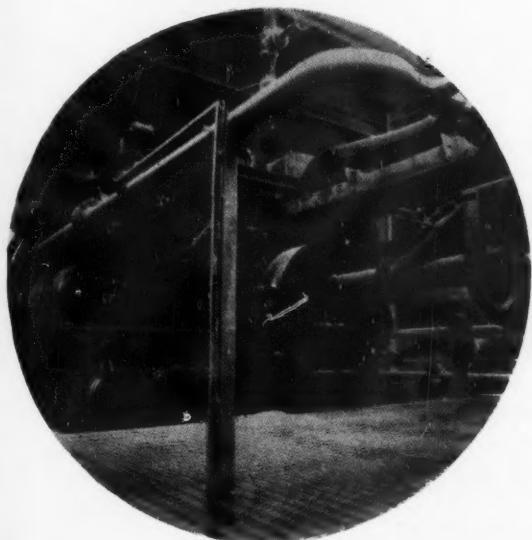
Miniature ball valves are suited for critical control of fluid flow since little effort is required to rotate the valve handle and the ball is supported by Teflon seat rings.

Valves are available for both

*New Equipment
continued on page 166*



**500
tons of
process
piping...**



***Fabricated and erected
by Midwest***

for Kaiser



Aluminum's

Baton Rouge plant

For this alumina processing plant of Kaiser Aluminum & Chemical Corporation in Baton Rouge, more than 500 tons (1,550 pieces) of piping were fabricated at the Midwest plant and erected by a Midwest field crew of 250. Midwest also installed slurry pumps, desilicators, monohydrate digesters, flash tanks, liquor heaters, storage tanks and other equipment.

Midwest's practical experience, complete facilities and skilled personnel—in the plant and in the field—can serve you efficiently and economically, whether you need a single fabricated assembly or an entire piping job for your plant or its power station.

Write today for 24-page illustrated brochure **POWER AND PROCESS PIPING**, describing Midwest's capabilities in the fabrication and erection of piping. Includes numerous case histories on piping projects of all sizes and types.



**MIDWEST
PIPING**

A DIVISION OF CRANE CO.
1450 South Second St. • St. Louis 4, Missouri

OUT-OF-SIGHT Waste and Refuse Storage for Your Plant



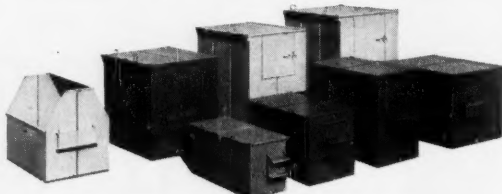
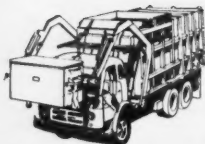
Plant-Owned System or Private Hauler Service Cuts Your Costs... Eliminates Unsightly Trash Piles

If trash piles, battered cans, scattered refuse, fire hazards and hit-or-miss collection are present in your plant, it may pay you to investigate the DEMPSTER-DUMPMaster System.

You can own your own system or secure this vital service without capital outlay from one of the many Dumpmaster-equipped private haulers who operate in most major cities.

Clean, big - capacity containers, spotted at refuse accumulation points throughout your plant, provide enclosed, out-of-sight storage for waste and refuse, increasing plant cleanliness and improving employee morale.

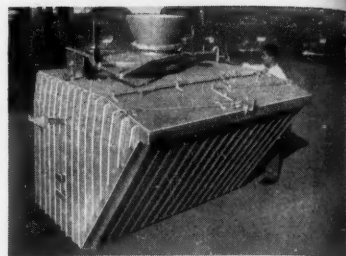
Write today for a free brochure that describes this system and the name of your nearest private hauler.



ONE OF THE
DEMPSTER
SYSTEMS

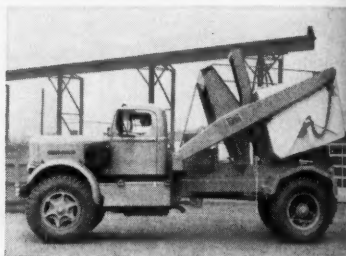
FREE BROCHURE
Write for Name of Your Nearest Private Hauler
DEMPSTER BROTHERS
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Dept. CE-7 KNOXVILLE 17, TENNESSEE

NEW PRODUCTS



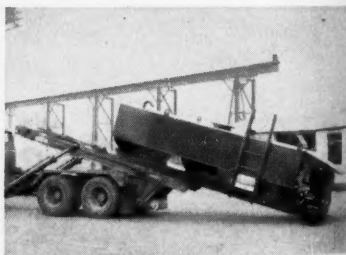
CONTAINER FOR HOT MATERIALS

This 6 cu. yd. tilt-type container was specially built to store and handle a high - temperature dusty product. It has cooling fins, a counter-balanced spring-hinged lid and a 16" sliding gate valve. When full it is picked up, hauled and emptied by a Dempster-Dumpster. Details are contained in a free brochure entitled "Special Containers." Dempster Brothers, Inc., Knoxville 17, Tenn.



NEW LFW HANDLES CONTAINERS

This new LFW 603-C, mounted on a White Mustang, was produced to handle scrap metal storage containers. It will handle containers in capacities up to 15 cu. yds. in all Dempster-Dumpster models. Lifting capacity is 18,000 lbs. Dempster Brothers, Inc., Knoxville, Tenn., offers a catalog brief No. 160 describing this and other materials handling systems.



PORTABLE FUEL OIL TANKS

This 2,000-gallon tank was produced for operation at temperatures as low as -90° F. It features its own pump and gasoline engine. Prime mover is a truck-mounted Dempster-Dinosaur which hydraulically lifts the tank into carrying position and puts it off. A new catalog section No. 12 describes the development. Dempster Brothers, Inc., Knoxville 17, Tenn.

Advertisement

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RING

A CLEAN FRESH DRINK ...from salty water

From the highly mineralized salt water found in the deep wells of New Mexico, the fast growing city of Roswell will soon draw fresh drinking water into its municipal system. The Office of Saline Water (U.S. Department of the Interior) selected CATALYTIC from a group of sixty-five firms for the architect-engineering assignment of the conversion demonstration plant which will make this possible.

This is another example of CATALYTIC'S versatility as engi-

neers and constructors in all fields of today's complex industrial expansion and the national defense program.



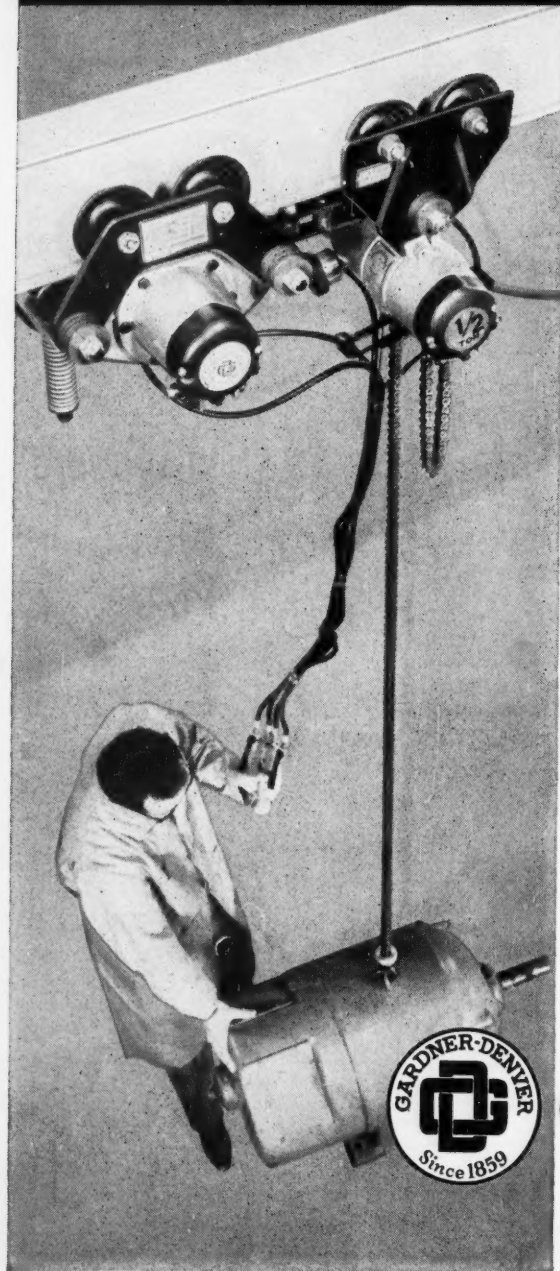
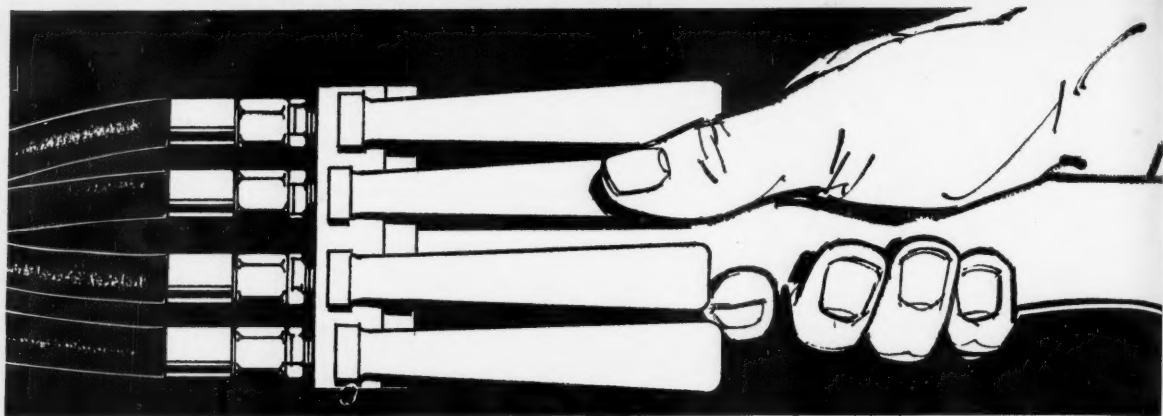
CATALYTIC

CONSTRUCTION COMPANY

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In Canada: Catalytic Construction of Canada, Limited; Sarnia, Ontario





POWER TEAM ON THE BEAM

Gardner-Denver "Hoistractor"® and air hoist combination teams two-way power to save time and reduce fatigue. Hoist lifts and lowers . . . "Hoistractor" moves hoist and load along the beam. Section 86 and 87 bulletins.

GARDNER-DENVER AIR HOIST AND "HOISTRACITOR"

- One-hand control of all movements.
- Air motors can't spark or burn out.
- No damage from overload stalls.
- Protected from dirt, dust, moisture, corrosive fumes.
- Designed for maximum safety.

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GARDNER - DENVER

Gardner-Denver Company, Quincy, Illinois—Offices in principal U. S., Canadian and Mexican cities

In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Ave., Toronto, 16, Ontario

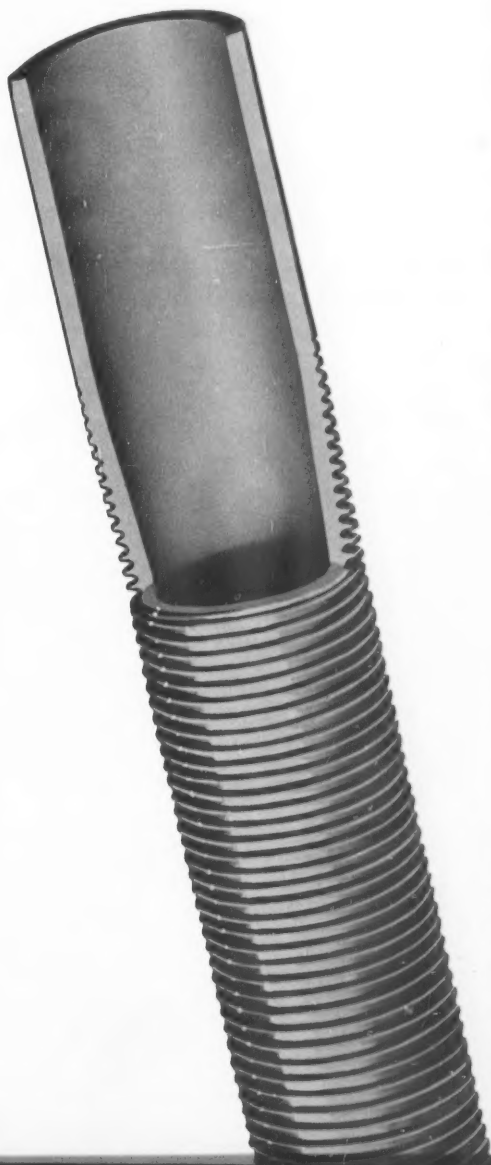
International: Gardner-Denver International Division, 233 Broadway, New York 7, N. Y.

International Offices: Buenos Aires, Argentina; Artarmon, N.S.W., Australia; Brussels, Belgium; Rio de Janeiro, Brazil; Santiago, Chile; Barranquilla, Colombia; Lima, Peru; Ndola, N. Rhodesia; Salisbury, S. Rhodesia; Johannesburg, Transvaal

Buying Heat Exchanger Tube?



If you are, then naturally you're looking for top value for your tubing dollars. That's exactly what you'll get when you specify heat exchanger tubes made the Tubemanship way by Wolverine. You can specify both prime surface tubing or Wolverine Trufin®—the integrally finned heat exchanger tube that boosts shell side heat transfer surface in both condensers and heat exchangers. Each is available in a wide range of types, alloys and sizes. Wolverine Tube's complete condenser tube lineup is pictured on the reverse page. Look them over, and then specify the type—or types—you need. You'll find that because of Tubemanship—*there is a difference in tubing.*



WOLVERINE TUBE

DIVISION OF

Calumet & Hecla, Inc.

DEPT. P, 17232 SOUTHFIELD RD., ALLEN PARK, MICH.

TUBEMANSHIP in Copper—Copper Alloys—Aluminum—Special Metals

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA
SALES OFFICES IN PRINCIPAL CITIES

BUY WOLVERINE HEAT EXCHANGER TUBE . . . the product of EXPERIENCE

Experience, dependability, engineering, research — if these are the things you look for when specifying heat exchanger tube you'll find them—in full measure—at Wolverine Tube. You'll find, in addition, a wide selection of tubing types—each designed to help you increase heat transfer efficiency. These tubes are illustrated and described on this page. You can choose any . . . or all of them . . . secure in the knowledge that no finer tubing is made. May we have your next order?

PRIME SURFACE TUBE

Wolverine prime surface heat exchanger tube is available in a wide range of sizes in copper, copper alloys and aluminum alloys. It is produced to ASTM Specifications B-111.



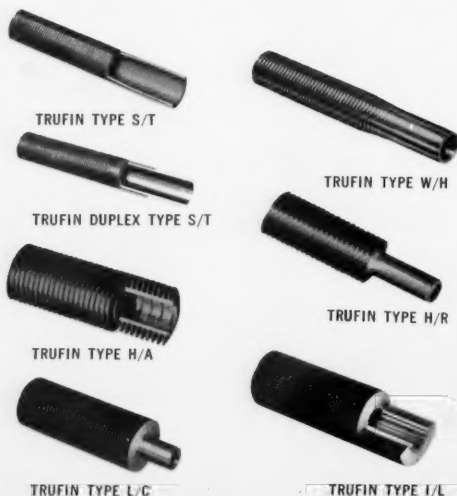
DUPLEX PRIME SURFACE TUBE

Composed of inner and outer tubes of dissimilar metals this tubing is specially designed to handle two different corrosive conditions at the same time. The metal combinations can be chosen to meet the requirements required to combat your corrosion problems.



WOLVERINE TRUFIN®—THE INTEGRALLY FINNED TUBE

Wolverine Trufin — the original integrally finned tube is manufactured in 7 different types. It is available in external helical low or high fin form or with internal, longitudinal fins. Your Wolverine Sales representative will give you the *complete* story — just ask him next time he calls.



WOLVERINE U-BEND PALLETS

Here is real convenience. Working to your specifications, Wolverine prefabricates these tubes and ships them to you in disposable box-type pallets—in the exact order of unit installation. They're real time savers that also help you reduce tube inventory. Wolverine U-bends are available in both finned or prime surface form.



WOLVERINE FIELD ENGINEERING SERVICE

This is a Wolverine "extra"—a staff of highly trained tubing technicians, ready at all time to help you solve heat transfer problems dealing with tubing alloy corrosion or design. Just ask for these services . . . there is no obligation.



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PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA
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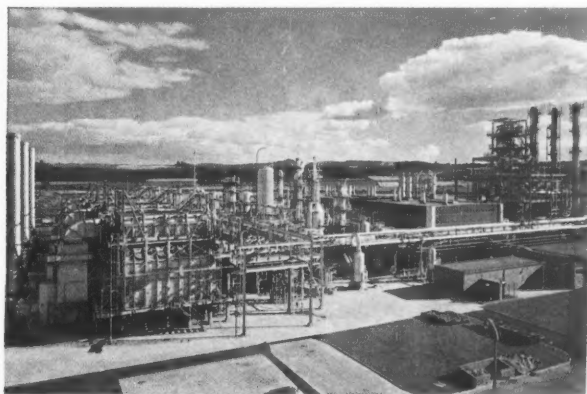
Wolverine Trufin is available in Canada through the Unifin Tube Division, London.

STONE & WEBSTER CONSTRUCTS A SCOTTISH GIANT

FOR BRITISH HYDROCARBON CHEMICALS LIMITED . . .

Completed ahead of schedule in June, 1960, Number 3 Ethylene Plant for B. H. C. at Grangemouth, Scotland was designed and constructed by Stone & Webster Engineering Limited. The new plant is one of the largest ethylene units outside the United States.

The plant employs the Stone & Webster process reflecting cumulative experience gained over a period of years from the design of over 36 ethylene plants processing a wide variety of feed stocks. Maximum stream time, heat economy, simplicity of operation and minimum maintenance are basic to this process. We would welcome the opportunity to review how our skills and experience could prove profitable to your next engineering project.



STONE & WEBSTER ENGINEERING CORPORATION

AFFILIATED WITH STONE & WEBSTER ENGINEERING LIMITED (LONDON)

New York, 90 Broad Street Boston, 49 Federal Street Chicago Houston San Francisco Los Angeles Seattle Toronto Calgary



FULLER PNEUMATIC CONVEYING SYSTEMS INCREASE PRODUCTION, CUT CONTAMINATION FOR GOODYEAR

Recent installation of specially engineered Fuller Airveyor® pneumatic conveying systems to handle pelletized rubber has helped Goodyear Tire and Rubber Company increase production. These systems are the latest Fuller design resulting from over 15 years experience in pneumatic conveying of rubber pellets. These completely enclosed automatic systems virtually eliminate contamination problems and greatly reduce the chance of loss due to spoilage.

Automated handling of crude rubber with Fuller Pneumatic Conveying Systems, in place of conventional rubber slab sheeting on a mill, is the key. One Airveyor system conveys the pelletized rubber from the pelletizer to a weigh station, a distance of 500 feet. Four more systems operate from the sink dump scales to inlet spouts of the finish-run Banburys.

All of these Airveyor pneumatic conveyors are of the vacuum type, employing positive pressure exhausters for air supply. Each conveying system is equipped with its own individual bag-type filter, automatic in operation, which provides for 100% visible dust retention. Exhausters and filters are located on the roof. A control panel permits manual or automatic operation of the entire handling system.

If you are handling dry, bulk, granular materials, a Fuller Conveying System application-engineered to your process can be equally advantageous. Look to Fuller, whose range of products coupled with experienced know-how offers you the best *single source* for solving pneumatic materials handling problems. Just call or write Fuller today outlining your problem—no obligation, of course.

A-288
1954

"See Chemical Engineering Catalog for details and specifications"



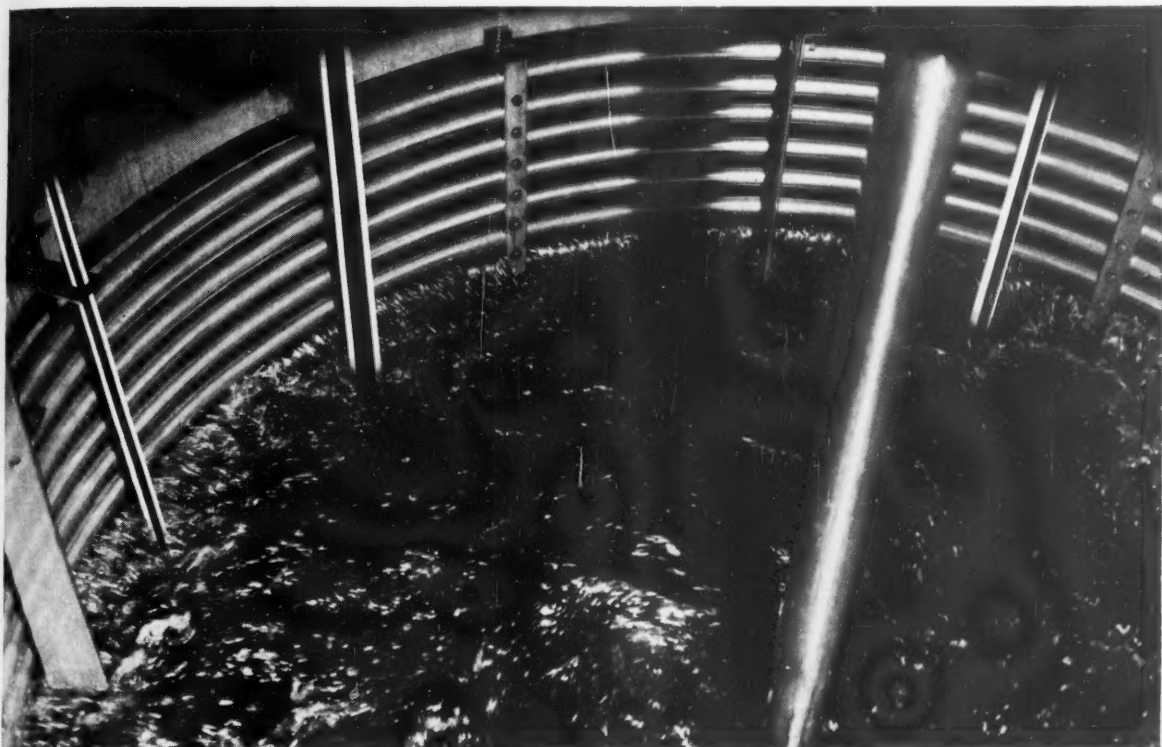
FULLER COMPANY
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THE PURECO CO₂

BLUE LINE

sparges, inerts, purges special industrial lubricants

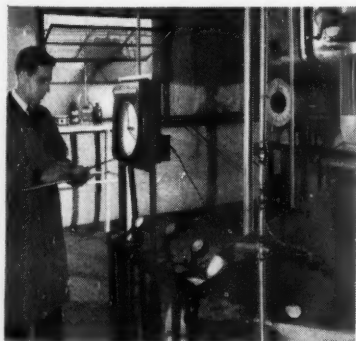


This huge new 5,200 gal. stainless steel reaction kettle at The Ironsides Company in Columbus, Ohio, makes multiple use of versatile Pureco CO₂ to protect product color and quality and to cut costs. The three CO₂ Blue Lines into the kettle do three separate jobs. CO₂ is *sparged*

from the larger of the 3 lines flushing out oxygen from the mixture . . . the second line spreads an *inerting* blanket of CO₂ on top of the mixture to keep out oxygen and other impurities. The third line is pressure *purged* to provide typical samples for testing.

Perhaps Pureco CO₂ Technical Service can save your company time and money, too!

New applications for Pureco CO₂ are being found constantly . . . new ways of doing things more efficiently and economically with this versatile chemical. The engineers in Pureco's Technical Service are highly trained in the application of its many uses . . . they are ready, willing and able to discuss, demonstrate or assist in the experimental development of CO₂ applications, whether they entail a new use for the product or the improvement of an existing one.



Use Pureco CO₂ Bulk Liquid and/or "Dry-Ice" as a refrigerant

Chill grinding of heat sensitive materials
• Chill grinding of animals' glands for hormones, etc. • Freeze-drying • Blast chilling of environmental test chambers.

Use Pureco CO₂ as a gas

Inert blanketing of dyes, inks and other flammable mixtures • Sparging of varnishes and other mixtures • Vehicle in distillation of phthalic anhydride in manufacture of resins • Flushing lacquer from TV tube interiors after optical coating • Inert pressure medium.

Use Pureco CO₂ as an ingredient

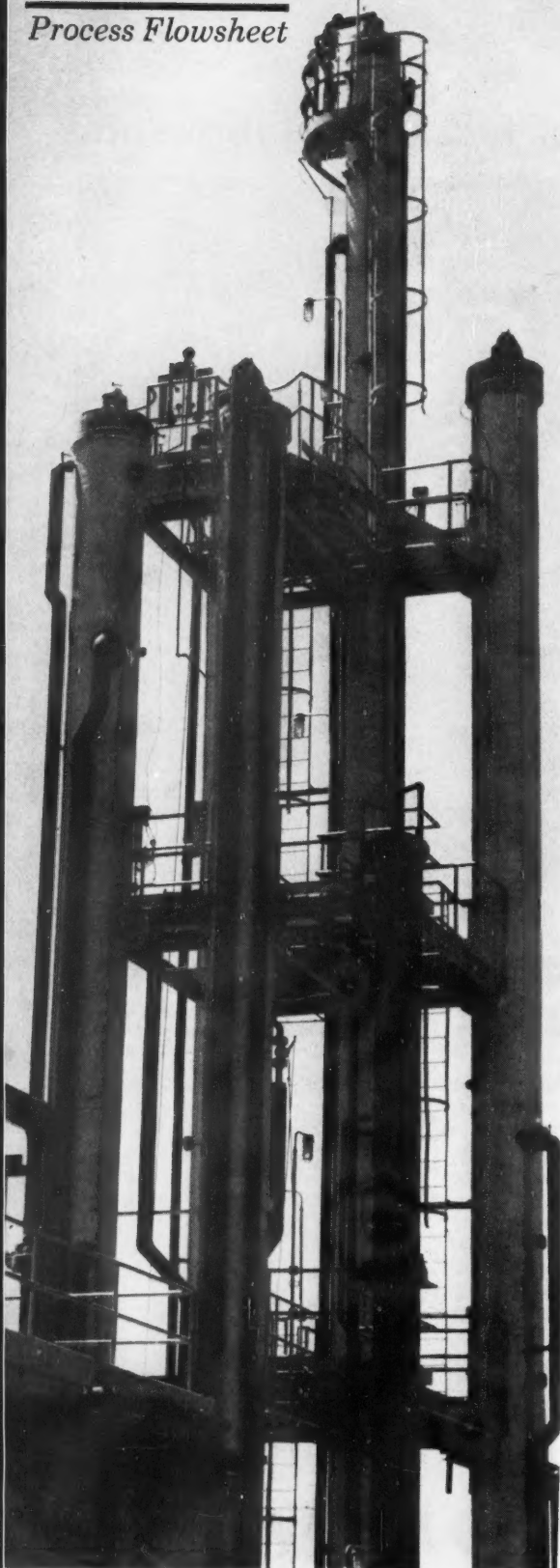
Forming carbonates, especially barium carbonates • Manufacture of aspirin • Controlling acidity—as in coagulating foam rubber.

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Pure Carbonic Company, A Division of Air Reduction Company, Incorporated
Nation-Wide Pureco CO₂ Service-Distributing Stations in Principal Cities
General Offices: 150 East 42nd Street, New York 17, N. Y.



Towers separate converter mixture into product amines.

Bullish Outlook Sires Methylamines Expansion

Prompted by a bright market picture, Rohm & Haas Co. has just completed a significant expansion of its methylamines capacity at Philadelphia. Here's an inside look at the technology behind the new unit.

N. P. CHOPEY,

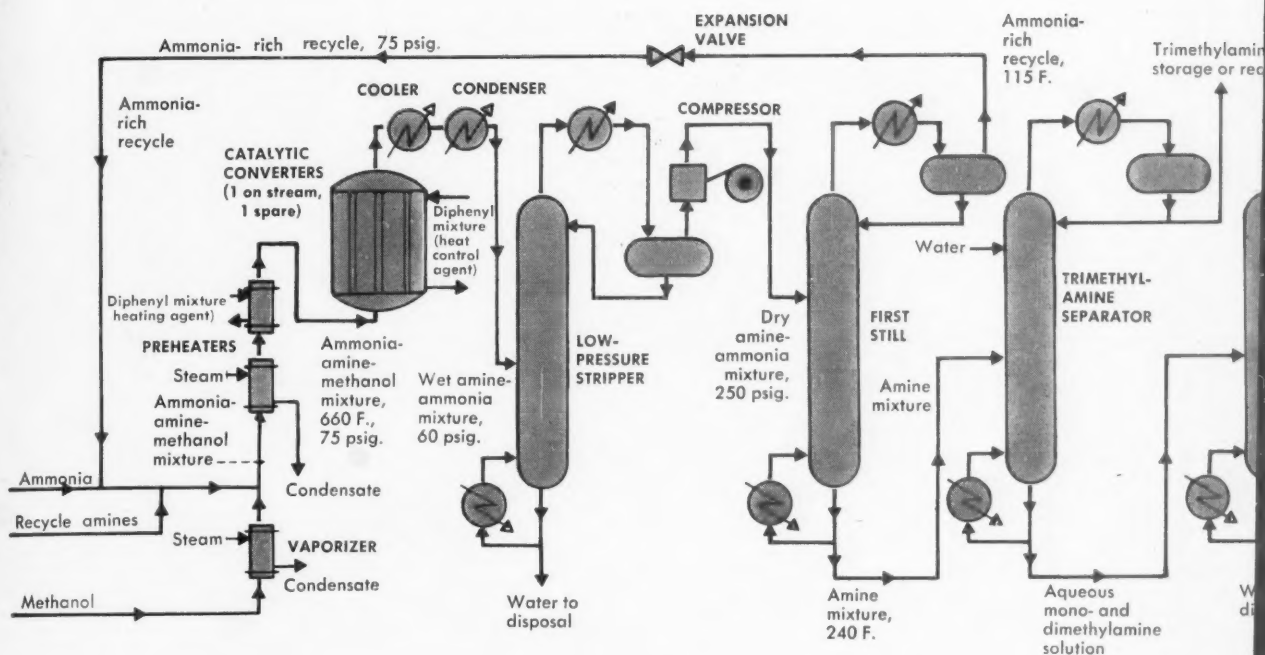
Assistant Editor

Latest evidence that methylamines producers are bullish about their future comes from Rohm & Haas Co.

Company has just placed a second methylamines plant on stream at its Philadelphia works, supplementing the output of an adjacent unit that has been making the amines since their commercial infancy in the early 1930's. The new plant constitutes the firm's third methylamines facility; there has been one operating at Bristol, Pa., since World War II days.

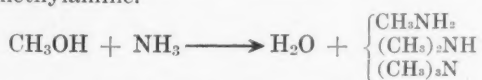
Probably the most publicized outlet for methylamines is unsymmetrical dimethylhydrazine rocket fuel, which is made from dimethylamine. Rohm & Haas points out that because of the uncertain outlook for this fuel, the firm's Philadelphia expansion might be considered somewhat speculative. But methylamines have numerous other outlets, including insecticides, accelerators for rubber manufacture, and solvents for acrylic fibers production, and the over-all market picture is clearly bright.

The firm isn't alone in thinking so: early this year, Du Pont put a new methylamines plant—its second—on stream at Belle, W. Va., with a capacity estimated at 20 million lb./yr.



Capacities of Rohm & Haas' Bristol and original Philadelphia units have been reported in the literature as 7-8 million lb./yr. each. Company isn't disclosing the output potential added by its new Philadelphia facility, says only that it provides a significant increase.

► **In a Nutshell**—Raw materials for methylamines manufacture are methanol and anhydrous ammonia, which react directly to yield mono-, di- and trimethylamine.



In brief, Rohm & Haas reacts ammonia and alcohol at high temperature, strips out water and recycles unreacted ammonia, then separates the three amine products. Company obtains its desired proportion between the three by recycling portions of the product streams other than the one to be maximized, and by adjusting the base: methanol ratio in the feed to the amine-producing reactor. This ratio can range from 1.5, for maximum trimethylamine, to 4.0 for maximum monomethylamine.

► **First Steps**—Feed methanol is vaporized by steam, then combines with ammonia plus recycled

amines. Mixture passes through two heat exchangers in series, in which steam and a diphenyl-diphenyl oxide mixture heat the stream to about 660 F.

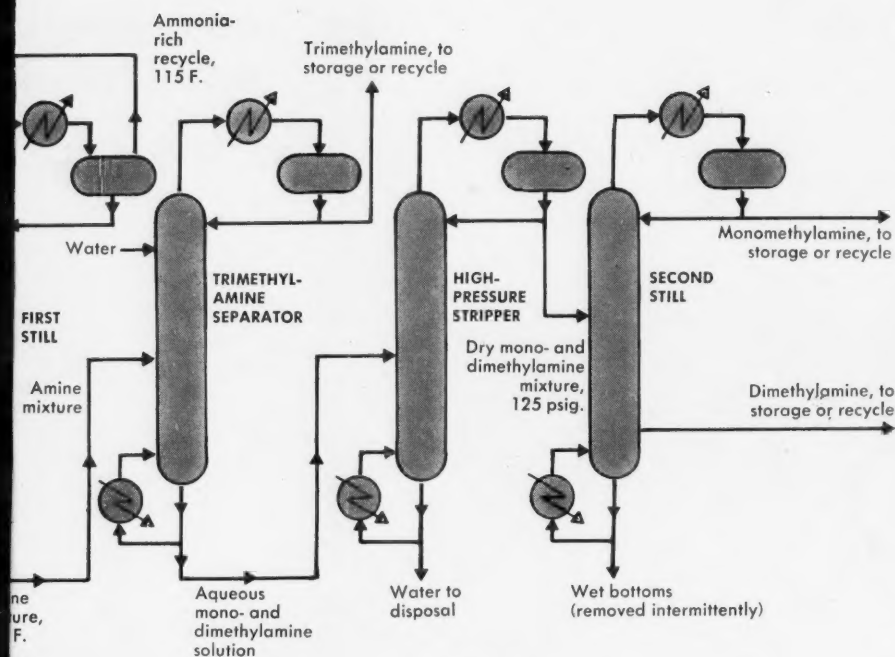
Process stream, at 75 psig., then enters a vertical reactor and passes upward through tubes containing an undisclosed dehydrating catalyst. Heat control is by means of diphenyl-diphenyl oxide mixture, and the amines-producing reaction takes place at 660-750 F.

Product mixture is cooled and condensed, then enters a low-pressure stripper that operates at around 60 psig. Water—virtually amine-free—leaves as bottoms and goes to the city sewer; overhead dry mixture of amines and unreacted ammonia passes through a one-stage reciprocating compressor that raises the stream pressure to 250 psig.

► **Ammonia and Amines**—The compressed, gaseous mixture feeds to a still for ammonia removal. Ammonia stream, leaving overhead at about 115 F., is actually a binary azeotrope containing some 7% trimethylamine; it passes through a reducing valve that lowers the pressure to 75 psig., then recycles to the beginning of the process.

Meanwhile, the mixed-amines bottoms stream

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passes through two heat exchangers, which steam and a diphenylamine heat the stream to about

at 75 psig., then enters a column. It passes upward through tubes and a dehydrating catalyst. The catalyst means of diphenyl-diphenylamine amines-producing reaction at 115 F.

The stream is cooled and condensed, then enters a stripper that operates at 125 psig.—virtually amine-free—water goes to the city sewer; the stream of amines and unreacted water goes through a one-stage reciprocating compressor, which raises the stream pressure to

125 psig.—The compressed, gaseous stream enters a still for ammonia removal. The overhead, leaving overhead at about 115 F., is a binary azeotrope containing water and amine; it passes through a condenser, which lowers the pressure to 75 psig., and enters the beginning of the process. The bottoms stream of mixed-amines bottoms stream

emerges at 240 F., goes to a 100-ft. column where extractive distillation with water yields trimethylamine as overhead product, ready for storage and shipping. Column operating pressure is about 175 psig., and the water is introduced near the top.

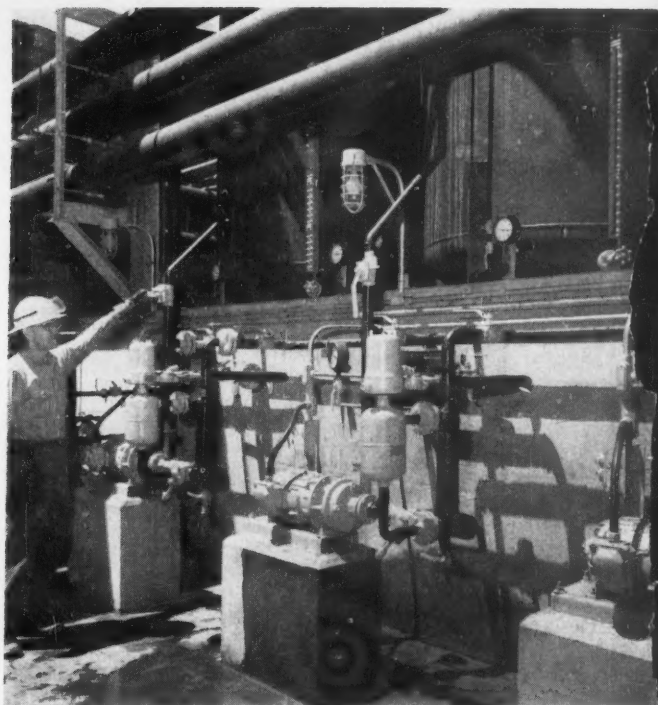
Column bottoms is a 25-35%, aqueous solution of mono- and dimethylamine. It goes to a second stripper that removes the water added in the previous step. Water-free product then enters a still for final separation of the two amines.

This vessel operates at 125 psig., yields monomethylamine overhead. The di-product is removed a few plates up from the bottom of the column, to assure that there is no residual water in the stream. Water bottoms are allowed to accumulate and are removed as required.

Rohm & Haas' three methylamines plants incorporate bubble-cap trays, sieve trays and packing among the five separation columns downstream from the converter at each plantsite. Packing is generally Raschig rings. Except for the 100-ft. trimethylamine separator, all the columns at the new Philadelphia unit are about 70 ft. high. Ordinary steel is the principal material of construction throughout the plant.

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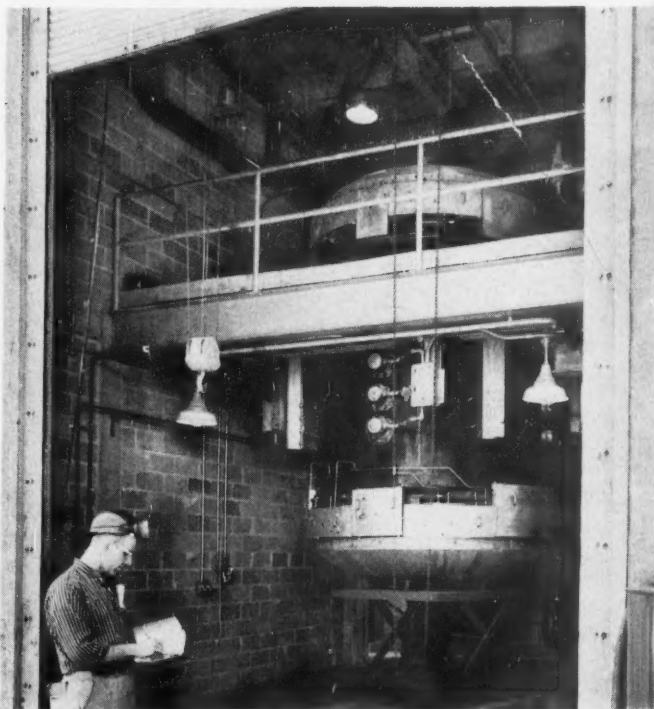
Pumps send amines to shipping, or recycle them to process. Recycle helps control proportion among three products.

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C... houses tubes that contain a dehydrating catalyst. Plant has one converter on stream, one spare.

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New Shell pocket computer helps calculate the evaporation rate of a hydrocarbon solvent in minutes—can be used right at your desk

Shell has invented a handy six-inch computer that lets you calculate solvent evaporation rates at your desk. It's called the Evapo-Rater.*

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New Shell Evapo-Rater, above, determines solvent evaporation rates in minutes. Shell is offering the Evapo-Rater to help users select the correct hydrocarbon solvent.

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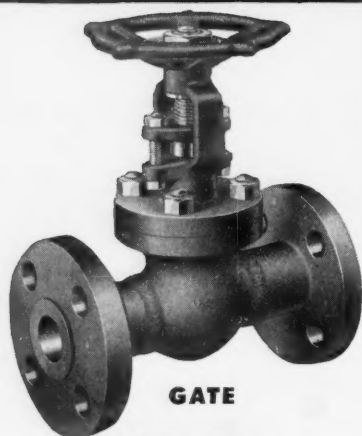
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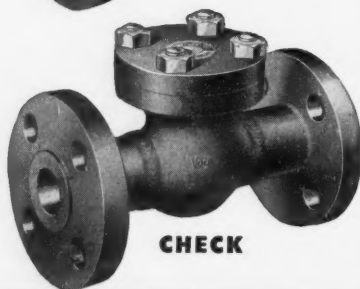
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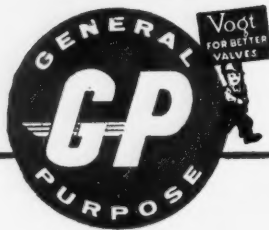
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Just now being completed, the Hallam, Neb., Nuclear Power Facility will have a 75,000-kw. (electrical) capacity. The reactor (left) and the new coal-fired plant (right) will both supply steam to the turbogenerator.

New Nuclear Plant To Have Radiation Available for Processing

Hallam, Neb., power-reactor demonstration plant, first full-scale sodium-graphite reactor in U.S., will be in full operation next summer, with available radiation equivalent to 45 tons of radium.

EDWARD G. LOWELL, *Atomics International*

Large quantities of byproduct gamma radiation can be made available next summer when the nation's first full-scale sodium graphite reactor (SGR) is started up at the Hallam, Neb., Nuclear Power Facility. Radioactive Na-24 in the system's primary cooling circuit will have a total activity estimated at 40,000,000 curies, equivalent to 45 tons of radium.

With moderate capital investment, a significant part of the resultant radiation can be used for chemical processing. While much larger installations are possible, a typical \$500,000 facility can provide 20 kw. of gamma radiation at about \$1.20/kwh., a figure

well below comparable estimates for accelerators or nuclide sources. At this price, radiation processing warrants fresh consideration by many sections of the chemical industry.

Today's most likely application for this facility is the polymerization of such monomers as styrene, vinyl chloride and methyl methacrylate, in solution or emulsion. While this process is not yet in common use, several investigators have reported that it is far less temperature-dependent than the conventional peroxide process and that it yields a superior, high-molecular-weight product.

Based on published dosage figures, the 20-kw. facility described in this article could process 20-40 million lb./yr. of polymer at a cost of less than 1¢/lb. Whether this figure will prove attractive to individual chemical companies will depend on logistics, as well as on product quality. Transportation costs will help determine the potential of Hallam radiation as a new chemical processing tool.

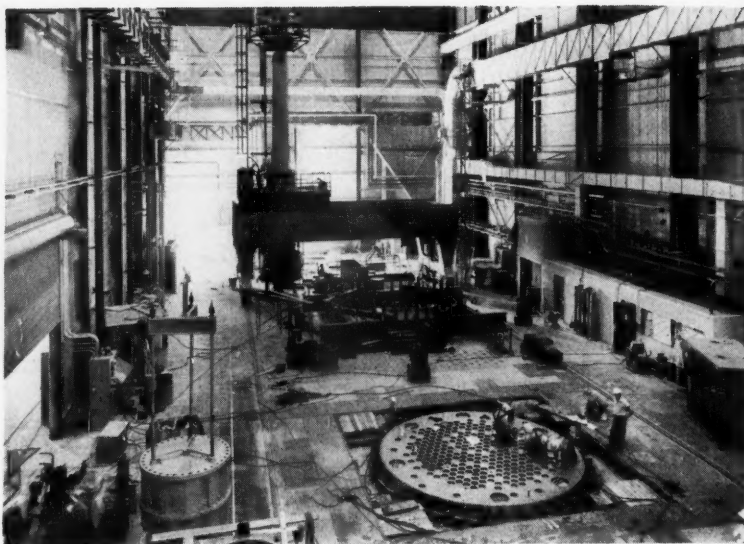
Who's Who at Hallam

The Hallam power plant, referred to in the nuclear jargon as HNPF, is being constructed as part of the Power Reactor Demonstration Program of the U. S. Atomic Energy Commission. Located on a site owned by the Consumers Public Power District, the 241-mw. (thermal) reactor and its associated equipment will be partially owned by the Commission, and will supply steam to the turbogenerator owned and operated by the utility. Under an agreement between the principals, the utility will operate the reactor and pay the Commission for the nuclear fuel consumed.

Atomics International, a division of North American Aviation, Inc., designed the plant's nuclear system and also fabricated the fuel elements and many nuclear components. Bechtel Corp. and Stearns-Roger Mfg. Co. provided engineering services; Peter Kiewit's Sons is managing construction.

Completion of the plant has been planned for July 1961, with initial criticality scheduled for the

Reactor bay shows loading face shield in foreground, fuel handling machine at the rear. Loading face has 208 openings, will accommodate fuel elements, control rods, instruments. Heavily insulated fuel handling mechanism is moved by 175-ton gantry.



following October. Six months of testing and low-power operation are scheduled before the plant goes on the line in the summer of 1962.

Design of the Reactor

Like most heterogeneous reactors, the SGR is essentially a large heat exchanger, in many respects similar to an electric immersion heater. Heat is supplied by fission of the uranium atoms in the reactor's 137 fuel elements. These are arranged in tubular fuel channels, through which circulates the primary coolant, liquid sodium. As shown in the schematic flow diagram, Fig. 1, the primary coolant transfers its heat to a secondary coolant stream in a more-or-less conventional shell-and-tube exchanger. This secondary coolant, also sodium, generates high-temperature steam (850 psi., 833 F.) in the plant's three steam generators.

While the use of a secondary-coolant loop increases the approach temperature, and thus slightly decreases the plant's over-all efficiency, this loop serves a valu-

able purpose in isolating the high-pressure steam system from the primary coolant.

In the reactor core, the primary sodium is subject to intense neutron irradiation (about 10^{13} neutrons/sq. cm./sec.) and a very small part of it (0.02% per year) is converted to Na-24. The latter is a radioactive isotope with a half life of 15 hr. It decays to stable Mg-24 with the emission of one beta particle and two energetic gamma rays (1.37 and 2.75 Mev., respectively). While the beta particles are quickly absorbed by surrounding material, the gamma rays have great penetrating power. This requires that the primary sodium equipment and piping be placed in heavily shielded subterranean vaults.

The neutron absorption by Na-23 atoms and the radioactive decay of Na-24 atoms proceed concurrently. After the reactor has run at full power for about two days, equilibrium between formation and decay is reached, with the primary coolant having a specific activity estimated at 0.18 curies/cc. With approximately 7,000 cu. ft. of sodium in the primary system, the total activity is 40,000,000 curies. While this is a huge amount of radiation, design of the reactor provides for its safe containment.

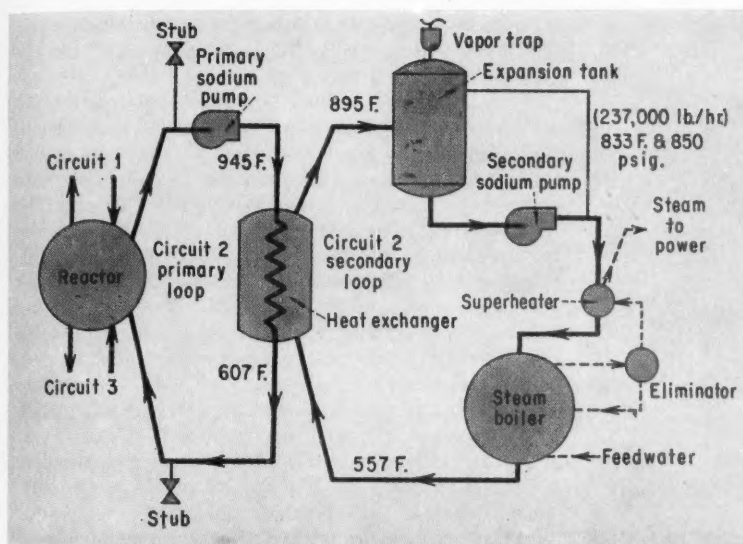
If a small side stream is diverted from the primary system to radiation assemblies in separate shielded vaults, a part of this radiation can be utilized in various processing applications. The same engineering techniques used for containment of the power plant's primary sodium system can be used to insure the safety of the irradiation facility.

Possible Uses for Radiation

Over the past three years, several uses have been considered for Hallam byproduct radiation, most of them related to food processing. In 1958, Atomics International conducted a primary design study of a

Some Radiation Unit Relationships

1 curie	Radiation associated with 1 gram of pure radium
	3.7×10^{10} disintegrations/sec.
1 Mev.	10^6 electron volts
Radiation power (watts)	$0.00592 \times \text{activity} \times \text{energy level}$ (curies) (Mev.)
1 rad	Absorption of 100 ergs/gram of material
	1.26×10^{-9} kwh./lb.



Flow diagram shows the main heat transfer system of the Hallam power plant. Note valved stubs close to the reactor, provided to enable radioactive sodium to be withdrawn from the primary loop for use in radiation processing.—(Fig. 1)

food-irradiation facility to handle a variety of agricultural products.¹ Among the processes considered were:

- Cold sterilization of canned goods.
- Pasteurization of meat to increase shelf life under refrigeration.
- Treatment of potatoes, onions, etc., to inhibit sprouting in storage.
- De-infestation of grain to destroy weevils and similar vermin.

Atomics International's evaluation staff developed a feasible design for such services and estimated the cost of construction at \$750,000, without materials-handling equipment. A section of its report, covering the economics of various food products, indicated that the unit cost of irradiation would be quite low.

But, a major obstacle remained. The U. S. Food and Drug Administration had not yet approved any radiation-processed foods for human consumption. Thus, the AEC received no proposals from food-handling or food-processing firms to construct such a plant.

Intensified research in radiation food processing is scheduled for a cobalt-60 facility now under construction at Natick, Mass. While Hallam radiation, because of the amount involved and other considerations, does not lend itself to use in a research unit, its potential for production is substantial. Recognizing this fact, the Commission authorized installation of valved pipe stubs during construction of the primary loops, to provide for future additions to the sodium system.

Radiation for Reactions

Various developments in the past few years have called attention to the possible use of high-energy radiation in promoting or in effecting chemical reactions. Before exploring the application of Hallam

radiation in this manner, certain principles should be discussed briefly. Rigorous treatment is beyond the scope of this article, but may be found in excellent treatises on the subject.^{2,3,4}

One significant effect of radiation is its ability to penetrate matter and to disrupt the binding forces between atoms. This is particularly true of gamma radiation, which can penetrate great distances in both solid and liquid materials. A number of results are possible, but the most frequent processes are those of ionization and free-radical formation.

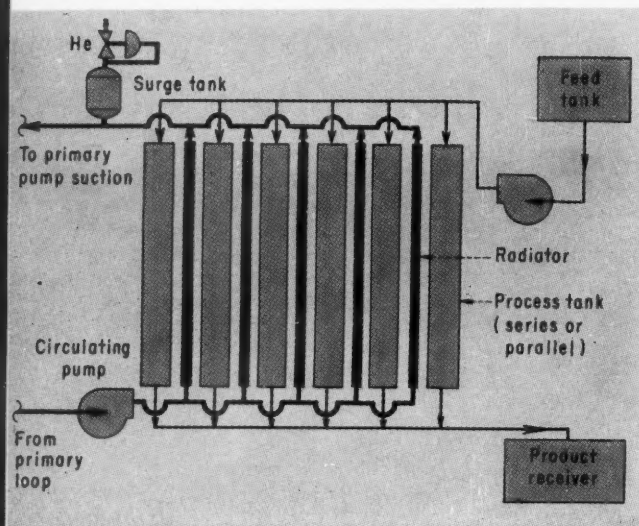
Usually, only a small fraction of the energy of the gamma photon is consumed in each collision, and thus passage of the gamma ray through the material results in a trail of ions and free radicals. These are highly reactive and, according to the chemical species and the conditions, proceed to form new molecules.

Mechanism of Reactions

The subsequent reactions can be divided into two general categories—chain reactions and nonchain reactions. In the former, we have an exothermic process that requires a certain activation energy for its initiation, but then proceeds by itself. In the latter case, we generally have an endothermic reaction, in which radiation-activated radicals combine with one another, but do not activate additional molecules.

Of the few nonchain reactions that are of current interest for radiation processing, none seems to be suitable for the Hallam facility. The production of hydrazine (a dimerization) requires far too much radiation energy—20-40 kwh./lb. of product—to be economically interesting.

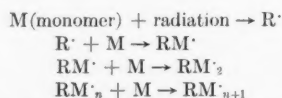
In the cross-linking of polymers, two parallel molecular chains are joined at some place along their structures to give three-dimensional frameworks yielding superior physical properties. As this process



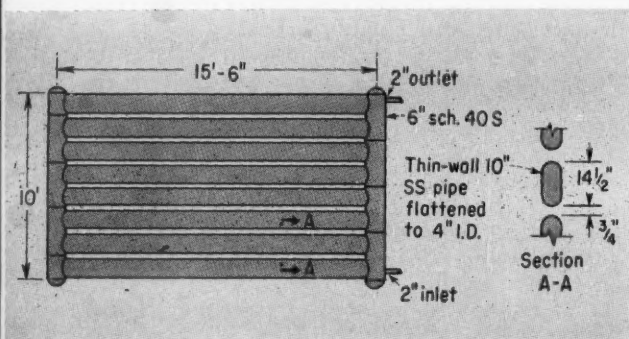
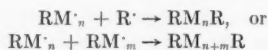
Proposed processing plant would use tubular sodium radiators alternating with rectangular process tanks.—(Fig. 2)

involves irradiating solid materials, it is easier to expose them to the required dose quickly in the intense beam of an electron accelerator than to use the diffuse radiation of activated sodium.

In some chemical situations, we find a different mechanism taking place. Radiation produces a free radical that immediately attacks a neighboring molecule of monomer, forming a larger excited molecule and initiating a chain. This combines with the next monomer molecule, and so on, until ultimately terminated.



This growth can end by reaction of the chain with a free radical or by mutual termination with another chain.



Radiators would be 15½ x 10-ft. assemblies of thin-wall pipe to minimize gamma ray self-absorption.—(Fig. 3)

If the intensity of radiation is excessive, the concentration of radicals is too high, and termination is too rapid. This results in reduced polymer and a reduced conversion rate.

Many of these radiation-induced polymerizations are best carried out in aqueous solution or in emulsion. Ballantine and Manowitz² found that emulsified styrene polymerized 100 times as fast as the pure monomer and yielded greater molecular weight. The increase in efficiency is attributed partly to dilution, which lessens the probability of primary radicals reacting with one another, and partly to greater radical formation in the solvent. Other monomers that can be effectively polymerized in solution or emulsion are N-vinylpyrrolidone (a blood-plasma substitute), methyl methacrylate and vinyl chloride. Indications are that acrylonitrile, vinyl acetate, and methyl acrylate can be similarly polymerized.²

Several authors have observed that a lower intensity of radiation not only is more efficient but also produces polymers of greater molecular weight and superior physical properties. For the emulsion polymerization of styrene at 70 F., an intensity of 60,000 rads/hr. gave a conversion rate of 36%/hr. and a molecular-weight range of 800,000 to 1,500,000.³ While slightly higher temperatures increase the conversion rate, exposure times of 2 to 4 hr. seem to be required for full polymerization. Commercial production by this process would thus require a facility in which a large volume of liquid could be irradiated at one time.

Such conditions are ideal for the application of Hallam coolant which, although a source of relatively low specific activity, is available in large quantities. Accordingly, it lends itself to the design of a facility that would handle large volumes of liquid at whatever throughput was desired.

Design for a Process Facility

Fig. 2 is a schematic flow diagram for a chemical processing plant using the byproduct radiation from HNPF coolant. Five sodium radiators, piped in parallel, are alternated with six rectangular process tanks that can be in series or in parallel, as the process requires. The radiators are stainless steel pipe assemblies 10 ft. high by 15 ft.-6 in. long, as depicted in Fig. 3. The pipe wall thickness is only 0.109 in., to minimize absorption by the container. The process tanks, also 10 ft. high by about 16 ft. long, are 2 ft. thick which, for aqueous solutions or emulsions, permits absorption of 95% of the incident radiation. The walls of the process tanks are ¼-in. aluminum, with adequate stiffeners. Internal baffles provide proper circulation and agitation of the process stream.

The five radiators, plus piping and associated equipment, have a combined sodium volume of about 260 cu. ft., which, when added to the reactor's primary system, reduces the specific activity from 0.18 to 0.173 curies/cc.

Using this value in a three-region shielding calcula-

lation for the two gamma-ray energies involved, we can obtain the heat-generation rate at each point in the process stream. Converting this to radiation units, we get instantaneous dose rates across the tank as shown in Fig. 4 and listed in Table I. Because of progressive absorption by the liquid, material in the center of the tank is subject to less radiation than that near the wall. Turbulent flow, however, mixes the stream and equalizes the exposure. The average dose rate for all six tanks is 1.2×10^5 rads/hr. and the radiation power of the facility is about 20 kw.

The total volume of the process tanks is 1,920 cu. ft. or 14,330 gal. If we assume that a 5% emulsion of styrene will be completely polymerized by an integrated dose of 180,000 rads, we obtain a residence time of 1.5 hr. Total solution throughput is therefore 80,000 lb./hr., while polymer output is 4,000 lb./hr. Based on an 8,000-hr. year, this equals an annual production rate of 32 million lb.

In discussing economics, we must assume that the proposed facility would be part of a somewhat more extensive chemical plant. Means would have to be provided for supply of monomer, for preparation of process solution, and for the filtration, drying, and packaging of the polymer. All these operations would also be present in a conventional process; the costs discussed herein apply, therefore, to radiation processing alone.

How Costs May Run

The cost of the described facility is estimated at \$500,000, exclusive of land. Applying a fixed-charge rate of 23% (5 year write-off, 6% interest) against the estimated investment would result in annual charges of \$115,000.

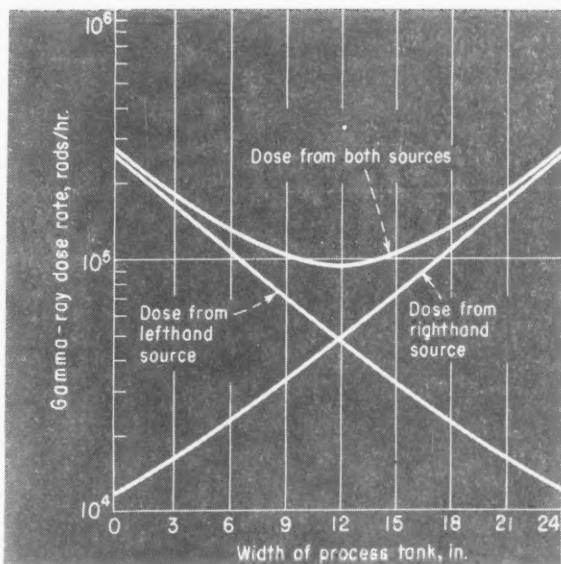
We estimate that the facility would be available for radiation processing about 8,000 hr. per year. The utility and the chemical plant would have the common objective of reaching the highest plant factor possible.

Operating and maintenance costs may be estimated as follows: An operating crew of one man per shift should suffice for that part of the plant shown. With an allowance for overhead and supervision, this time should not exceed \$6/hr. For 4.3 shifts, this is equal to \$53,000/yr.

Because of the relative simplicity of the facility, maintenance cost should be low. Experience with the Sodium Reactor Experiment, and with numerous sodium test loops at Atomics International's nuclear field laboratory near Los Angeles, supports a maintenance estimate for the sodium circulation system of less than 2,000 man-hr./yr. Accordingly, a maintenance allowance of \$20,000/yr. seems adequate to cover the entire facility.

Power requirements, including cooling of the vault, are estimated at 50 kw. A rate of 10 mills/kwh. would result in a power cost of \$4,000/yr. Finally, it is assumed that the utility will make no charge for use of the active sodium.

A breakdown of the unit costs gives the picture shown in Table II.



Radiation dosage varies with position in tank (see also Table I). Calculation is for aqueous contents.—(Fig. 4)

Since a detailed design of the facility has not yet been made, the costs given in the table are somewhat uncertain, especially the capital investment. It is interesting to note, however, that a 50% increase in the fixed charges would still leave the unit cost at less than \$0.01/lb.

Hallam vs. the Competition

These costs compare very favorably with those of alternative radiation sources such as radioisotopes and accelerators. Arthur D. Little, Inc., in a comprehensive survey of radiation uses,⁶ estimated the cost of a 30-kw. irradiation facility using cobalt-60 at about \$3.50/kwh.; of one using cesium-137, at about \$4/kwh. Furthermore, to obtain even these estimates, the costs of the radioactive sources were projected to values considerably lower than any demonstrated to date.

The same report estimated the cost of machine radiation at about \$2/kwh. But, the direct use of this radiation in chemical processing is not effective, since electrons have slight penetrating power. To promote

How radiation intensity varies across process tank—Table I
(Calculated for aqueous contents)

Distance from Lefthand—Dose Rate, 10 ⁴ Rads/Hr.			
Interface, In.	LH Source	RH Source	Total
3	16.52	1.62	18.14
9	7.25	3.37	10.62
15	3.37	7.25	10.62
21	1.62	16.52	18.14
Average	14.38

Estimated cost for nuclear radiation facility—Table II

Fixed charges, \$/yr.....	\$115,000
Manpower, \$/yr.....	53,000
Maintenance, \$/yr.....	20,000
Power, \$/yr.....	4,000
Total, \$/yr.....	\$192,000
Facility radiation power, kw.....	20
Operating time, hr./yr.....	8,000
Radiation absorbed, kwh./yr.....	160,000
Unit cost, \$/kwh. of radiation.....	1.20
Polymer output, lb./yr.....	32,000,000
Unit cost, \$/lb. polymer.....	0.006

chemical reactions, the electron beam of an accelerator must first be used to bombard a target and generate X-rays. These can then be passed through an aluminum window into the process stream. In as much as efficiency for X-ray production is not over 40%, the effective cost of the machine radiation is much greater than the figure given.

Since sodium can be piped but a short distance, Hallam byproduct radiation must be used near the reactor. Thus, as materials to be irradiated must be brought to the facility, transportation costs must be carefully considered.

Advantages of Hallam Site

This problem can be solved by building an integrated chemical processing plant next to the nuclear power station at Hallam. While this is a big undertaking, many factors favor its establishment. For example:

Site—Land is plentiful. Hallam is a small farming community 20 miles south of Nebraska's capital city, Lincoln. The utility has a 600-acre industrial site, much of which would be available for further development. Surrounding farmland is extensive.

Transportation—Excellent transportation facilities exist. The main line of the Rock Island Railroad runs through the site, while four additional railroads serve Lincoln. The site is four miles from U. S. 77, which leads directly to Interstate 80. Barge transportation on the Missouri River is about 70 miles away.

Utilities—Nebraska has large indigenous water resources with abundant underground supplies in the Hallam area. Both electric power and steam would be available from the utility at favorable rates. A 100,000-kw. conventional power plant on the same site insures continuity of service.

Raw Materials—Natural gas, LP gas, coal and limestone are all readily available. The conventional power plant, served by a large transmission line, burns gas on an interruptible basis. A new 8-in. pipeline will soon carry 40,000 bbl./day of LP gas from Bush-ton, Kan., close by the Hallam site, to Des Moines, Ia.

Coal comes to the plant via the Rock Island Railroad, which is establishing a specific rate for this commodity in view of its use in power production.

Labor—While the region is primarily agricultural, ample industrial labor can be obtained at Lincoln. With a population of 135,000, the city has an experienced work force estimated at 70,000, of which about two-thirds are men. In addition, the surrounding farm communities represent an untapped source of labor skilled in handling machinery. Industrial relations in the area are reported to be excellent.⁷

Several chemical companies and oil companies are known to be active in radiation-processing research. This activity, now generally concealed for proprietary reasons, may soon bring new products to the market and result in the development of improved methods for producing existing products. For those radiation processes that involve polymerization, byproduct gamma radiation soon to be available at the Hallam Nuclear Power Facility may prove to be a useful and economic tool. Best utilization of this radiation, however, suggests construction of an integrated chemical plant at the Hallam site.

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Meet the Author



EDWARD G. LOWELL, a member of *Atomics International's* technical evaluation staff at Canoga Park, Calif., has been with that firm over five years. His 24-yr. career also includes five years in the *Chemical Welfare Service* during World War II, as well as process engineering stints with *Arthur G. McKee & Co.* and *C. F. Braun & Co.* Registered as an engineer both in New York and California, Lowell has long been active in the *National Society of Professional Engineers*. He is a former director of the California society, representing the San Fernando Valley chapter and a former president of the Pasadena chapter. He received his chemical engineering degree from *Rensselaer Polytechnic Institute* in 1937.

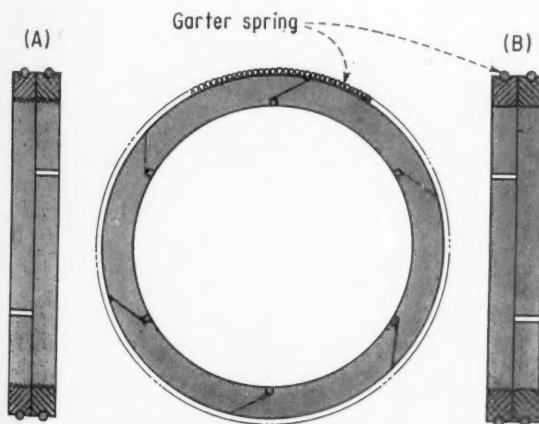
Some popular misconceptions about packings may lead you to accept scored rods, wasted packing, leakage or frequent shutdowns as necessary evils. Here is an approach that may change your thinking.

Reciprocating-Rod Packings Need Not Be Trouble Spots

WALTER COOPEY, *Engineering Consultant*

By applying some rather simple principles, we were able to drastically reduce packing changes in various stages of gas compressors. Furthermore, the life of the rods was greatly increased and plunger failures were eliminated.

We will discuss approaches that can help bring about similar improvements. While the principles are intended to apply specifically to metallic and soft packings in high or superpressure service, the information can also be used to advantage for low pressures. A very successful method for solving soft-packing problems associated with rotating shafts was discussed in my previous article,* so that we can now concentrate on reciprocating rods and plungers.



Original packing element (A) is serrated and has sharp edges; modified packing element (B) has lapped surfaces and rounded edges.—(Fig. 1)

There are two basic factors in packing applications—a lubricant film must be developed between rubbing surfaces to keep friction at a minimum, and the lubricant should act as a sealing medium. Too often, it is stated that "the function of packing is to control leakage but not necessarily to eliminate it," and that "a slight leakage of process fluid is desirable." This is a defeatist attitude.

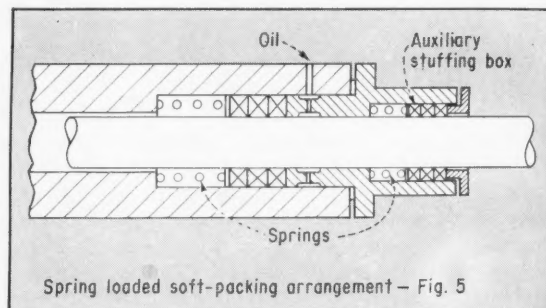
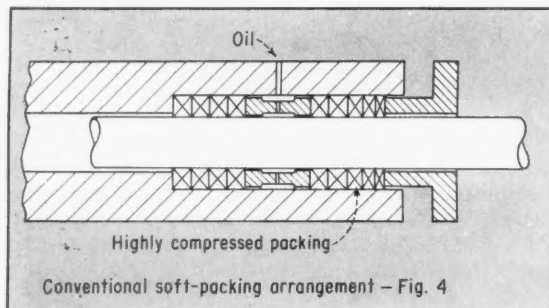
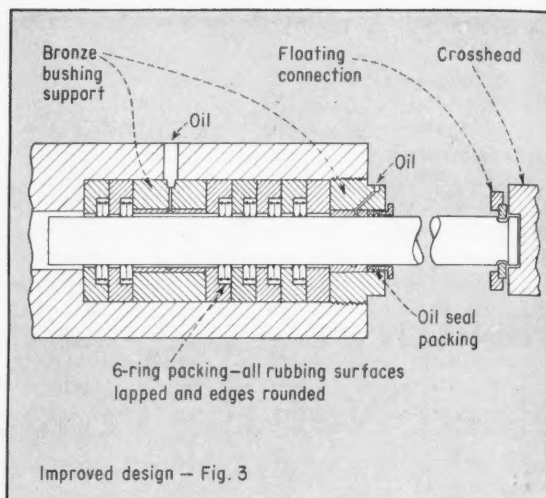
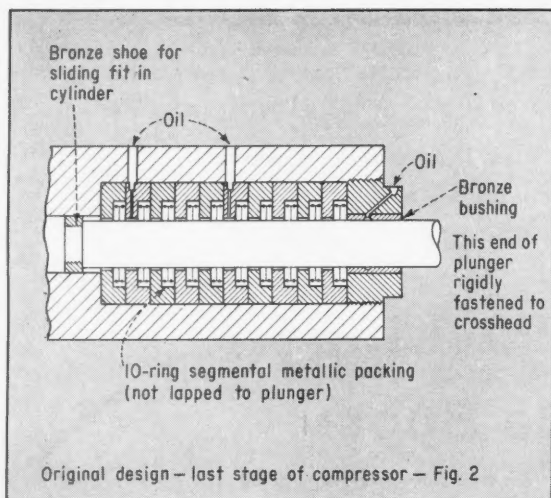
Wearing-In Means Wearing-Out

In the early development of a synthetic ammonia process, one of the many problems was poor performance of the rod packing for a 5,000-psi. four-stage compressor. The main source of trouble was the 4-in.-dia. third-stage plunger at 1,500 psi, and the 1½-in.-dia. fourth-stage plunger at 5,000 psi. Segmental metallic packing of cast iron was used on the former and a semiplastic lead-asbestos packing on the latter. Both of the plungers were surface hardened.

The performance of the packing was so poor that the operation of the process was frequently interrupted—particularly by the failure of the 4-in. plunger in the third stage. The packing in this stage consisted of eight rings in multiple retainers or compartments, as shown in Fig. 1. This type was widely used on steam engines, where it had given good service. However, the life of the packing in our application was less than two weeks. The plunger itself barely lasted a month before it had to be replaced.

At first, we assumed that deficient lubrication might be part of the problem, and provided an additional supply. But this was of no benefit. Even the inventor of the packing was called in, but he could offer no

* "How to Solve Soft-Packing Problems," *Chem. Eng.*, Jan. 27, 1958, p. 131.



suggestions to improve the installation. Apparently the conditions were different than they were at low pressures.

It was common practice for the manufacturer to furnish metallic packing with serrated wearing surfaces and sharp edges, on the supposition that the packing would "wear-in" to the rod and that the sharp edge would help to prevent gas leakage. When we observed that the oil from the packing was black due to the presence of finely divided cast iron, we began to suspect that the wearing-in theory might be wrong, particularly at higher pressures. Therefore, we decided to try something different. Instead of serrations, the rubbing surfaces were made smooth and the sharp edges were removed by honing. We thought that a rounded edge would permit the lubricant to get between the rubbing surfaces.

This was all that was done in this case, but the results exceeded all expectations. No third-stage packing change was required for the next two years, after which the compressor was transferred out of the writer's jurisdiction.

With the elimination of the third-stage problem, we reverted our attention to the plastic packing in the fourth stage. The difficulty was really not too severe, as the mechanics had developed a technique for installing and servicing it so that it was not a limiting

factor in the operation. However, we did make one significant change. Following the premise that "wearing-in" meant "wearing-out," we decided that all plungers and rods should have a "mirror finish," which was the best designation we could think of at that time for a highly polished surface. A few years later, a prominent automobile manufacturer independently discovered the value of this, and the term now used is "super-finish," and is usually expressed in micro-inches.

Several years later, a lubrication investigation led us to conclude that rounding the edges of packing not only prevents the scraping off of the lubricant, but also promotes the formation of an oil film between the rubbing surfaces. This is called "wedge action" or the "Reynolds Wedge". The theory is old, and is described in the book, "The Theory of Film Lubrication," by R. O. Boswell, which was published about a year after we realized the value of the rounded edge.

The Kingsbury or Michell thrust bearings, which are used almost universally for supporting the great loads on the shafts of vertical hydroelectric turbines, are based on this principle. While there may not seem to be much connection between large thrust bearings and metallic rod packing, the same oil film principles can be applied to both. The chief difference is that in one case there is a continuous movement, whereas in

the other, the movement is interrupted. In the Kingsbury and Mitchell type bearing, the oil film begins to form as soon as the disk starts to rotate.

Alignment Can Be Critical

As pressures are increased, the packing problem becomes more difficult. It then becomes essential to follow the basic principles that were described in the previous article on soft packing.

Special emphasis should be placed on obtaining as near perfect alignment as possible. It is better to provide means to compensate for slight misalignment than to rely completely on construction accuracy, since it is difficult to construct large-scale equipment with the required precision, and even more difficult to maintain proper alignment under severe service conditions.

What can be accomplished is best illustrated by a specific example. Fig. 2 shows the original packing arrangement for the last stage of a compressor operating at 13,000 psi. The 4-in.-dia. plunger had three points of support—the crosshead to which it was attached rigidly; a bushing or bearing at the outer end of the packing assembly; and a bronze shoe that acted as support and guide for the end of the plunger, and gave a sliding fit in the cylinder.

There were ten sets of packing rings made of a bronze composition, and these were installed as received from the packing manufacturer.

Perhaps the most serious adverse factor in this arrangement was the impossibility of getting good alignment. The net result was that high-temperature stresses developed, and the average operating life of both the plunger and the packing was less than two weeks. Because the plunger frequently seized or broke in the packing, a serious hazard was created when the massive machine was brought to almost a dead stop. We took progressive steps to remedy the causes of trouble, and these resulted in an arrangement similar to that shown in Fig. 3. The changes were:

1. Design of a floating connection for attaching the plunger to the crosshead. Actually, this connection could only compensate to a limited extent for initial discrepancies in aligning the crosshead guides with the cylinder. When under pressure, there was no movement at this connection because of the heavy load on the end of the plunger, and hence it could not compensate for any movement of the crosshead in the guides.

2. Elimination of the shoe on the end of the plunger. Another adequate bushing support was provided as shown. We located this support so that it could be well lubricated, and so that the oil hole would not cause fatigue failure. (In its old location, one segment to the left, the oil hole was much more likely to be the source of fatigue failure, due to the high alternating stresses in the area.) The new support made alignment much easier.

3. Reduction of the number of packing rings from ten to six. All the rubbing surfaces were carefully lapped and the edges rounded to permit wedge action. Although this type of packing is considered to be "floating," it only floats at relatively low pressures—below 500 psi. Above this level, the higher the pres-

sure, the more firmly will the packing be clamped to the plunger.

It is usually assumed that there is a pressure drop along the length of a packing assembly and that all the rings contribute to holding the pressure, but this is not so. A test with taps between each set of rings showed that the first two rings nearest the cylinder were doing practically all the work. The rest of the rings could be considered spares.

4. Specification of a plunger finish 5 micro-inches or less. Test data have shown that, with bearings, a finish of 3 to 7 micro-inches increases the load carrying capacity very noticeably. The contact between a rod and packing may be considered similar to that between a bearing and a shaft.

The effect of these steps was gratifying. Even though alignment at times was still not quite perfect because of limitations in the original design of the compressor, the average packing life was increased to over a year, and failures of plungers were eliminated.

The improved installation demonstrated some important facts. Rubbing-surfaces that are finished to a high degree require only a relatively thin film of lubricant, and experiments with bearings have demonstrated that a hydrodynamic film of 0.00001 in. is adequate. Rounding the edges of the packing rings is necessary to develop a film.

It is common practice to specify as many as ten rings of packing for 5,000 psi., whereas less than half this number should be sufficient. Three rings properly fitted and with rounded edges are better than 12 rings with sharp edges, which have not been fitted to the rod. In the latter case, because there is the poorest kind of boundary lubrication, materials must be chosen for their wearing qualities; with film lubrication, other considerations can govern.

Conventional vs. Spring-Loaded Arrangements

It is extremely difficult to fit metallic packing segments together so that they are absolutely tight. If liquid is forced at high pressure through a small fissure or crack, "wire-drawing" takes place, which will cut out the packing very quickly.

This is not a problem with gases. Hence they are usually sealed with metallic packing, while liquids are sealed with soft or plastic packing.

Fig. 4 shows a fairly conventional soft-packing arrangement for both rotating shafts and reciprocating rods. In this system, lubricant is fed to a lantern ring that is interposed between sets of packing. In some cases, the lantern ring is located at the bottom of the stuffing box; in others, it is dispensed with entirely and the stuffing box is filled with packing.

Lubricant is introduced at the lantern ring, presumably with the expectation that it will reach the point of highest friction. When there is no lantern ring, dependence is placed upon the lubricant in the packing. In any case, the point of highest pressure, as indicated on the sketch, is next to the gland, where the packing is most highly compressed. To reach this point, the lubricant must travel the full length of the packing, instead of taking the path of least resistance

into the cylinder. Furthermore, under this arrangement, it is easy for the lubricant to be wiped off, or to be diluted by the liquids being pumped.

Because of the high compression and resulting friction at the outer rings of the packing, this is where most of the wear originates. In the case of a rotating shaft, the wear pattern is circumferential, but with a reciprocating rod it is axial, and therefore scoring will pass through the length of the packing.

A secondary effect is that at high pressures the packing is forced to the outer end of the stuffing box, leaving a void at the inner end. Then, because of the movement of the rod and the turbulence of the fluid, the inner packing is agitated and may disintegrate, so that pieces of it can foul the pump valves.

Constant attention is required to adjust the packing but, as has been so aptly stated, the man with the wrench can be a dangerous person. He can be responsible, though unaware of it, for scored rods, excessive down-time and wasted packing. Of course, if some leakage of process liquid is permitted, as is frequently advocated, it might help lubrication, but at high pressures this could be hazardous if permitted to go unchecked.

Other disadvantages are that the lubricating system must be designed for maximum operating pressure, and that the lubricant might be a source of contamination. This could be an important factor in some applications.

Fig. 5 shows a packing arrangement that has solved most of the difficulties inherent in the conventional setup. A spring at the bottom of the stuffing box serves the double purpose of holding the bottom rings in place and effecting an initial seal, which helps the packing to become self sealing and self adjusting. This practically eliminates the human factor. The point of highest compression is still at the outer end of the packing next to the gland, but the difference in compression is much less marked.

For pressures of up to 5,000 lb./sq. in., the auxiliary stuffing box shown in the drawing is not required. If the oil is just dropped on the rod outside of the stuffing box, it will adhere to the rod and provide the necessary lubrication.

The auxiliary stuffing box is essential for the most difficult applications, and for pressures in the superpressure range. By introducing the lubricant at the point shown in Fig. 5, at a pressure at least equal to the suction pressure, not only will the main packing be better lubricated, but the pressure drop across it will be reduced so that the service becomes less severe.

The lantern ring, which has become part of the gland, will of course lubricate both the main and auxiliary packing. The latter will be required to hold the lubricant but at relatively low pressures this is not too difficult a problem.

Much has been written about choosing the best packings from the many types available. While selection of a style suitable to the conditions of service is important, poor performance does not necessarily mean that the packing is unsuitable—usually it's the application rather than the packing itself that causes 90% of the trouble.

Are Further Improvements Possible?

In the foregoing we have tried to show how and why packing performance can be greatly improved by the application of what should be rather well-known principles. But this is far from being the ultimate of what should be possible. The objective should be a frictionless packing with an indefinite service life.

Bridgman, in "The Physics of High Pressure," describes how, by using the balanced pressure principle in a free piston gage, extreme pressure can be retained with a fluid film. Using the wedge principle, Kingsbury and Michell have demonstrated that bearings can be built to support tremendous loads with an oil film. Therefore, by combining these two principles, it should be possible to develop a relatively simple packing element that would be effective for pressures to several thousand atmospheres.

Preliminary work has shown that a hydrodynamic pressure of 5,000 psi. is built up by moving a 1-in.-dia. rod at a speed of 100 ft./min. through a plain bushing having a wedge entrance. The lubricant was supplied at atmospheric pressure.

Some superpressure tests conducted on a seal element with a wedge entrance have further demonstrated what can be accomplished. The element was 2½-in. long with a 1-in. I.D. When lubricant at 1,200 psi. was supplied to it, satisfactory operation was obtained for over 2,000 hr. during pumping of a volatile liquid at 18,000 psi. There was not the slightest leakage during this period.

Precision workmanship would be essential in the manufacture of such a packing, but this should be a requirement for any superpressure packing. These ideas may sound radical, but not any more so than those of Bridgman and Kingsbury.

Meet the Author



WALTER COOPEY, an engineering consultant in Charleston, W. Va., has contributed to the development of a dozen high-pressure and superpressure processes. As packing performance is a particularly important factor in such operations, he has spent considerable time studying and improving packing applications.

His previous article on this subject (Chem. Eng., Jan. 27, 1958), met with considerable interest and approval—letters about it still come in from time to time.

Packings for reciprocating rods were not covered in that article; the present one should fill the gap.

Tables Speed Viscosity Conversion

W. MURRAY UNDERWOOD, Monsanto Chemical Co.

Of all the factors the chemical engineer must convert from one set of dimensional units to another, viscosity is probably the most annoying. It can be kinematic or absolute, in force units or mass, in English units or metric, and often occurs in several different combinations in the same equation. The theory of converting to dimensionally consistent units is not difficult.¹ However, the method is time-consuming and is likely to result in mistakes.

The chart given here was assembled to make viscosity conversions easier, faster and more accurate. It is an improvement over anything previously available because of its completeness and because it comprises two tables: one for conversion of values of absolute viscosity and the other for kinematic viscosity. Conversion between kinematic and absolute viscosities is by means of fluid density. The tables are related for convenience in doing this.

The English units used are those of the engineering system. The gravitational (force in pounds and mass in slugs) and absolute (force in poundals and mass in pounds) systems are not used here since they are rarely encountered in chemical engineering work. To distinguish between the two kinds of pounds used in the engineering system, mass pounds are designated simply as lb. and force pounds by a subscript *F*, lb._F. These are related by the conversion factor: 32.1740 (lb.-ft.)/(lb._F-sec.²).

In the metric system, the units of mass and force are clearly distinguished in most cases, although the term gram does sometimes appear as a unit of force. This happens, for example, in expressing pressures: one atmosphere is approximately 1,000 grams per square centimeter. If the gram is a unit of mass, this expression is, of course, meaningless. Pressures really ought to be expressed in dynes per square centimeter.

Perhaps the confusion results from the use of dead-weight testers for calibrating pressure gages. Whatever the reason, force grams (which are analogous to force pounds in the English engineering system) are seldom distinguished, except by context from mass grams. When they are, a force gram is usually called a gram weight. This terminology is used here. One gram weight is equivalent to 980.66 dynes.

All conversion factors in the tables were computed using five significant figures, and then were rounded to four. Each factor is given as a number between one and ten, multiplied by ten raised to the power and sign indicated in the parentheses. Thus, the factor 3.861 (+2) is 3.861×10^2 or 386.1, and the factor 1.020 (-3) is 1.020×10^{-3} or 0.001020.

To use either table alone, find both the units in which the viscosity is given in the column on the left, and the units wanted in the row across the top. Multiply the viscosity in the given units by the common

factor, to obtain viscosity in the desired units. If division is preferred, find the given units in the row across the top and the wanted units in left column.

For example: a polymer melt has an apparent viscosity of 10^6 centipoises. What is its viscosity expressed in Reyns?

$$\begin{aligned} 10^6 \times (1.450 \times 10^{-7}) &= 0.145 \text{ lb.}_F\text{-sec./in.}^2 \\ \text{or: } 10^6 / (6.895 \times 10^6) &= 0.145 \text{ lb.}_F\text{-sec./in.}^2 \end{aligned}$$

To convert between absolute and kinematic viscosity, the density of the fluid must be used. The relationship is: $\mu = \rho\nu$ where μ is absolute viscosity, ρ is density and ν is kinematic viscosity. Thus, a fluid viscosity in centistokes may be multiplied by the density of the fluid in g/cm.³ to obtain centipoises.

There are dimensions between the two tables that indicate the appropriate density units for conversion between the kinematic and absolute viscosity units in that column. Notice that conversion can be made between any viscosity units, using any density units with these tables. For example:

An oil has a kinematic viscosity of 22.0 centistokes and a density of 61.5 lb./cu. ft. What is its viscosity in Reyns? First, convert from centistokes to ft.²/sec. This is in a column where density in lb./ft.³ can be used for conversion to absolute viscosity. Then, convert this value, by division, to be units desired.

$$\frac{22.0 \times (1.076 \times 10^{-6}) (61.5)}{(4.633 \times 10^{+3})} = 1.428 \times 10^{-7} \text{ lb.}_F\text{-sec./in.}^2$$

These conversion tables do not take into account the many special viscosity units such as Saybolt, Redwood, Engler, Gardner-Holdt, etc. Tables for converting these values to centistokes or centipoises are readily available in Lange's Handbook,² Bates' article³ and other references. In the second example above, the value of 22.0 centistokes might have been the result of converting an original given value of 107.1 SSU at 210 F. to centistokes, by means of such a table.

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Meet the Author

W. MURRAY UNDERWOOD is research specialist in the research department of the plastics division of Monsanto Chemical Co. at Springfield, Mass. For the past ten years, his primary responsibilities have included the mechanical processing of high polymers, and research in rheology, thermal properties of polymers, measurement of temperature and pressure, diffusion and intensive mixing. He is a member of AICHE, American Institute of Physics, Society of Rheology and is a registered professional engineer.

These tables give conversion factors to change kinematic and absolute viscosity from one set of dimensions to another.

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Kinematic, $\nu = \mu/\rho$											
cm. ² /sec. (Stokes)	cm. ² /sec. (+2) (Centistokes)	m. ² /hr.	ft. ² /sec.	ft. ² /hr.	in. ² /sec.						
cm. ² /sec. (Stokes)	1	1.000(+2)	3.600(-1)	1.076(-3)	3.875 (0)	1.550(-1)					
cm. ² /sec. (+2) (Centistokes)	1.000(-2)	1	3.600(-3)	1.076(-5)	3.875(-2)	1.550(-3)					
m. ² /hr.	2.778 (0)	2.778(+2)	1	2.990(-3)	1.076(+1)	4.306(-1)					
ft. ² /sec.	9.290(+2)	9.290(+4)	3.345(+2)	1	3.600(+3)	1.440(+2)					
ft. ² /hr.	2.581(-1)	2.581(+1)	9.290(-2)	2.778(-4)	1	4.000(-2)					
in. ² /sec.	6.452 (0)	6.452(+2)	2.323 (0)	6.944(-3)	2.500(+1)	1					
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Density, ρ											
gm./cm. ³	gm./cm. ³	gm./cm. ³	kg./m. ³	lb./ft. ³	lb./ft. ³	lb./in. ³					
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Absolute, $\mu = \rho\nu$											
gm./cm. ² (sec.) (Poise)	gm./cm. ² (sec.) (+2) (Centipoise)	kg./m. ² (hr.)	lb./ft. ² (sec.)	lb./ft. ² (hr.)	lb./in. ² (sec.)	lb./in. ² (hr.)	(dyne) (sec.) / cm. ²	(gm./ft. ² sec.) / cm. ²	(lb./ft. ² sec.) / in. ²	(lb./ft. ² sec.) / ft. ²	(lb./ft. ² hr.) / ft. ²
gm./cm. ² (sec.) (Poise)	1	1.000(+2)	3.600(+2)	6.720(-2)	2.419(+2)	5.600(-3)	1.000 (0)	1.020(-3)	1.450(-5)	2.089(-3)	5.801(-7)
gm./cm. ² (sec.) (+2) (Centipoise)	1.000(-2)	1	3.600 (0)	6.720(-4)	2.419 (0)	5.600(-5)	1.000(-2)	1.020(-5)	1.450(-7)	2.089(-5)	5.801(-9)
kg./m. ² (hr.)	2.778(-3)	2.778(-1)	1	1.867(-4)	6.720(-1)	1.555(-5)	2.778(-3)	2.833(-4)	4.029(-8)	5.801(-6)	1.612(-9)
lb./ft. ² (sec.)	1.488(+1)	1.488(+3)	5.357(+3)	1	3.600(+3)	8.333(-2)	1.488(+2)	1.518(-2)	2.158(-4)	3.108(-2)	8.634(-6)
lb./ft. ² (hr.)	4.134(-3)	4.134(-1)	1.488 (0)	2.778(-4)	1	2.315(-5)	4.134(-3)	4.215(-6)	5.996(-8)	8.634(-6)	2.398(-9)
lb./in. ² (sec.)	1.786(+2)	1.786(+4)	6.429(+4)	1.200(+1)	4.320(+4)	1	1.786(+2)	1.821(-1)	2.590(-3)	3.730(-1)	1.036(-4)
(dyne)(sec.) / cm. ²	1.000 (0)	1.000(+2)	3.600(+2)	6.720(-2)	2.419(+2)	5.600(-3)	1	1.020(-3)	1.450(-5)	2.089(-3)	5.801(-7)
(gm./ft. ² sec.) / cm. ²	9.807(+2)	9.807(+4)	3.530(+5)	6.590(+1)	2.372(+5)	5.492 (0)	9.807(+2)	1	1.422(-2)	2.048 (0)	5.689(-4)
(lb./ft. ² sec.) / in. ²	6.895(+4)	6.895(+6)	2.482(+7)	4.633(+3)	1.668(+7)	3.861(+2)	6.895(+4)	7.031(+1)	1	1.440(+2)	4.000(-2)
(Reyn)											
(lb./ft.) (sec.) / ft. ²	4.788(+2)	4.788(+4)	1.724(+5)	3.217(+1)	1.158(+5)	2.681 (0)	4.788(+2)	4.882(-1)	6.944(-3)	1	2.778(-4)
(lb./ft.) (hr.) / ft. ²	1.724(+6)	1.724(+8)	6.205(+8)	1.158(+5)	4.170(+8)	9.652(+3)	1.724(+6)	1.758(+3)	2.500(+1)	3.600(+3)	1



Articles in This Series

1. Designing laminar-flow systems, June 12, 1961, p. 243.
2. Determining end of laminar region, June 26, 1961, p. 127.
3. Turbulent flow—a historical review, July 10, 1961, p. 147.
4. Designing turbulent-flow systems, July 24, 1961, p. 143.
5. How to handle slurries, Aug. 7, 1961, p. 129.
- 6. **Best Methods for Obtaining Flow Data.**
7. How to interpret data.

Best Methods for Obtaining Flow Data

Here is how to construct an extrusion rheometer for getting laminar non-Newtonian scaleup data; and advice on conducting turbulent tests.

RICHARD LeBARON BOWEN, Jr., *Coated Textile Mills, Inc.**

Laminar data for a $D\Delta P/4L$ vs. $8V/D$ plot are best obtained from an extrusion rheometer.

As we mentioned in Part 1 of this series, all that has to be measured of the fluid under study is the time a sample takes to pass through the rheometer tube, and weight and density of the sample. It is not necessary to calculate V in the $8V/D$ term, since $8V/D = 32q/\pi D^3$ where q is flow rate in cu. ft./sec.

It is very difficult to convert τ vs. (dv/dr) data from a rotational viscometer to the required $D\Delta P/4L$ and $8V/D$ terms. However, suitable data can also be developed from pipeline tests and should correlate with extrusion-rheometer data.

Buy or Build Your Own

While the name capillary-tube viscometer has been used for the extrusion rheometer, this is a misnomer, since the tubes are seldom of capillary size (with viscous materials) and the instrument does not operate on the gravity principle of the true capillary-tube viscometer. These devices are more properly called extrusion rheometers (they are pressurized at the top with gas).

Commercial varieties of extrusion rheometers are available from Burrell Corp., Pittsburgh, Pa. However, the one used in this study was constructed at Coated Textile to demonstrate how simple the instrument is (Fig. 18).

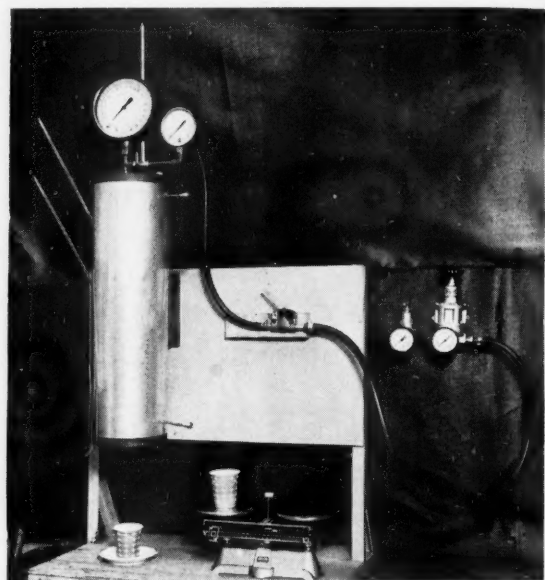
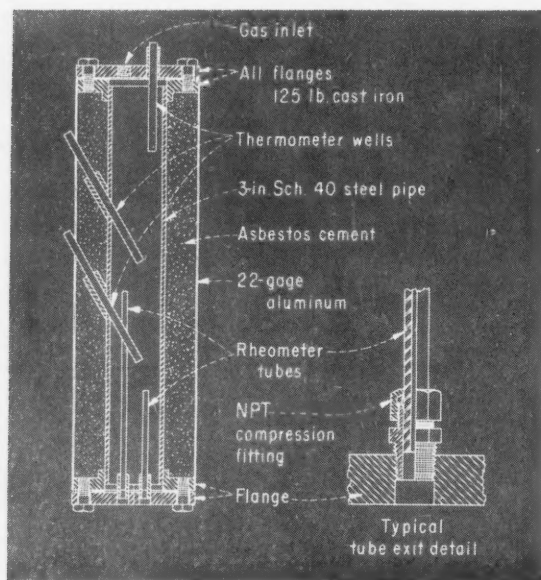
The reservoir consists of 3-in.-dia. pipe, 24-in. long, with standard 125-psi. flanges fitted at both ends. This makes it easy to take the equipment apart for cleaning. The stainless tubes are small-bore, $\frac{1}{16}$ to $\frac{1}{8}$ -in. dia., available from American Instrument Co., Silver Springs, Md., or Superior Tube Co., Norristown, Pa. (Alloy-steel tubes with bores as small as 0.004-in. are also available.) Tubes are held by compression fittings and go into a blind flange fixed to the bottom.

Actually, provision for two different-length tubes and two different diameters was made in the blind flange. Regardless of how they are fastened to the bottom, the tubes should extend into the reservoir with a minimum length extending outside.

Need Precise Gages

The only instrument constants to be determined are the inside tube diameter and length. There is no problem measuring length, but obtaining an accurate diameter is rather difficult. One way is to fill the bore with mercury and calculate from weight of mercury. Diameters of the $\frac{1}{16}$ -in. tubes we used were determined with mercury. In the absence of a supply of mercury, diameter can be calculated by using density of the stainless and accurately measuring O.D. The former method is recommended, since it is a direct measurement, while the latter method is indirect with inherent errors. Small bores must be calibrated from larger measured tubes in the rheometer. It was necessary to calibrate the $\frac{1}{16}$ -in. tubes used here by this method.

* For author biography, see *Chem. Eng.*, June 12, p. 248.

Extrusion rheometer yields data for scaling-up non-Newtonian laminar flow—Fig. 18

The blind flange fitted to the top flange has a pressure gage and a quick-coupling connection for a gas supply. The pressure gage should be a precision gage, and it should be checked before and after measurements with a dead-weight gage tester or standard test gage. Obviously, data collected will be no better than accuracy of the pressure gage.

Any gas can be used for pressurizing the rheometer, although air and oxygen should be avoided if the materials to be tested have solvents that form explosive mixtures with oxygen. Nitrogen is probably the best gas, and usually is readily available. A pressure regulator is necessary for changing pressure, and a three-way valve in the line holds pressure on the rheometer and relieves pressure after a measurement has been taken.

Small Tubes Cover Practical Range

With the viscous materials used in this study, 100 psi. was satisfactory for $8V/D$ or (dv/dr) of 10,000 sec^{-1} .

Many investigators believe that a certain range of shear-rates must be used for such experiments. Actually, only the shear-stress is of interest for pipeline sizing, since this converts directly to pressure drop per 100 ft. for any pipe size. For example, consider a $\frac{1}{2}$ -in. \times 12-in. tube used with a maximum of 100 psi. This gives a shear-stress of 75 lb./sq. ft., which for a 1-in. pipe represents a $\Delta p/100$ ft. of 2,500 psi., or 250 psi. for a 10-in. pipe. For most pipeline work, these values are excessive. To reduce $\Delta p/100$ ft., the value of $D\Delta P/4L$ must be reduced—this can be done by lowering D or ΔP , or increasing L .

Consider a $\frac{1}{2}$ -in. \times 12-in. tube with 5-psi. pressure, representing a $D\Delta P/4L$ of 0.47 lb./sq. ft., which would

give a $\Delta p/100$ ft. of 16 psi. for a 1-in. pipe and 1.6 psi. for a 10-in. pipe. The value of $8V/D$ and resulting gpm. will depend entirely on consistency or viscosity of the material. But tubes from $\frac{1}{2}$ -in. to $\frac{1}{4}$ -in. will probably cover the normal demands. However, an engineer can calculate the exact size of tubes he needs to get his particular requirements.

Reduce Pressure, Increase Length

The data illustrated in Fig. 2 of Part 1 of this series for the black-pigment dispersion in castor oil were taken in $\frac{1}{8}$ and $\frac{1}{4}$ -in. tubes, 6 to 12-in. long at pressures of 20 to 85 psi. To extend the data to lower values of $D\Delta P/4L$, it would have been necessary to reduce pressure and tube diameter, and also increase the tube length.

Using a $\frac{1}{8}$ -in. \times 12-in. tube at 5 psi. would have produced values of $D\Delta P/4L$ only $\frac{1}{8}$ as large as the minimum from the $\frac{1}{8}$ \times 6 in. tube at 20 psi. Thus, there should be no problem in obtaining the exact range of shear-stresses desired.

Temperature Affects Results

Anyone seriously contemplating collecting pipe-flow data with an extrusion rheometer should be forewarned to take the utmost precautions in measuring and correcting for (or controlling) temperature.

Temperature coefficient for most fluids is great, and with some Newtonian materials, viscosity can double with a 10 F. drop. Initially, three bimetallic thermometers with 1 F. subdivisions were inserted into the side of the rheometer reservoir with compression fittings. These gave reasonable results. But much more reproducible results were obtained by using three mercury

thermometers with 0.2 F. subdivisions inserted in wells fitted in the side and the top flange.

Actually, data collected in this study were obtained without any temperature control; the rheometer was set up in a plant area where a 30 F. daily temperature rise was not exceptional. Test material was placed in the reservoir, and a series of runs made as soon as the temperature leveled off. Temperature of the material in the reservoir, as well as that of the sample obtained from the rheometer, was noted. (There was usually a slight temperature increase from bottom to top of the reservoir.)

Protruding Tubes Introduce Error

Initially, tubes were fastened to the bottom of the reservoir so they projected down from the bottom blind flange. With such an arrangement, it was difficult to get data that correlated with any precision.

A most serious error in such a design is that the inside wall of the tube may be at a different temperature from the bulk temperature of either the sample or the reservoir. Since laminar conditions exist in virtually every case, serious errors can result if the wall temperature differs from bulk temperature. With the short length of tube used, a difference in wall temperature (from bulk temperature) will only change the temperature of a thin film at the wall, and this temperature will not be indicated by any change in bulk temperature of the sample.

The problem was solved by pushing the tube up inside the reservoir so it was surrounded by the fluid to be tested. Only the very end surface of the tube contacted the air, and the reservoir was insulated.

A test was made to determine effect of temperature differences between the tube (in the ambient) and the reservoir. Two short (3-in.-long) tubes were used, one projecting down from the bottom flange into the atmosphere and the other projecting up into the reservoir. With a temperature difference of 5 F., the difference in flow rates was about 2.5% at low flow rates (at 10 psi.), but at higher flow rates (at 50 psi.) the difference was less than 1%. Such discrepancies would not be serious in most instances, but they can be easily eliminated. With tubes inside the reservoir, data of remarkable reproducibility were obtained.

Similar results could also be collected with an uninsulated rheometer in a constant-temperature bath. If data are required at temperatures well above or below the maximum or minimum ambient temperatures, the rheometer must be placed in a constant-temperature bath. Low-cost laboratory constant-temperature baths are available for controlling bath temperature to ± 0.1 F. Since data are for pipeline scaleup, it is important to remember that they must be collected at the lowest temperature expected in the pipeline. If the temperature in the line will fall to 40 F. for only one day, the system should be designed for this even though it may require double the normal operating pump horsepower.

Laminar $\Delta P/4L$ vs. $8V/D$ data can be collected from an actual pipeline test. But temperature of the

material as well as temperature of the inside wall of the pipe must be known or controlled accurately. With very viscous materials, this becomes a problem. If a pump is used, it will undoubtedly generate a certain amount of heat.

A large volume of material will be required, and keeping this volume at a constant temperature is difficult. The inside wall temperature in a test pipe can be determined by embedding thermocouples in the wall of the pipe close to the I.D., or by providing thermometer wells.

Pipeline Tests Are Difficult

There is a further problem with pipeline tests. In the extrusion rheometer, pressure is accurately measured as a single gas pressure. But with the pipeline, several fluid pressures must be measured. This brings up problems of both proper design for pressure taps and of keeping material out of pressure gages and lines by purging the system.

Problems in collecting precise data on a pipe system are enormous compared with those of the extrusion rheometer. Since data from both types of measurements correlate on the same $\Delta P/4L$ vs. $32q/\pi D^3$ curve, laminar data should obviously be obtained from a rheometer.

Turbulent Data for Pipe

However, as we have pointed out before, turbulent data must come from pipeline tests. If the temperature cannot be controlled, it should be measured accurately before and after the test section. Fortunately, pressure drop is much less sensitive to temperature changes in the turbulent region. This is because pressure drop varies with the 0.25 power or less of viscosity in turbulent flow, while in laminar flow, pressure varies directly with viscosity.

Problems may also develop in pipelines with suspensions or settling slurries. In such systems, velocity in every other part of the fluid path (except the stirred tank) should be higher than the test section so any settling starts just in the test section.¹ Calming or entrance lengths of 50 pipe diameters should be included before the first pressure tap and exit lengths of greater than 12 pipe diameters should follow the last pressure tap, before any geometric discontinuity is introduced. At least three different pipe sizes must be used to obtain data for turbulent scaleup. Data from a single pipe is worthless as we have pointed out (see Parts 2 and 4).

Make Necessary Corrections

Some precautions are necessary in using the rheometer and treating data.

There are inherent errors in the instrument that must be considered. First is a head correction. Height of fluid above the tube exit must be added to gas pressure above the fluid. If there is 2 ft. of fluid, this might equal about 1 psi., which could be ignored at

150 psi. However, at 5 psi. this would amount to a 20% error.

Entrance Effects

Also, there are entrance losses due to sudden constriction of the fluid in passing from the reservoir into the tube. The velocity profile at the entrance of the tube is flat so the streamlines are not parallel to the axis at the upper end of the tube. Liquid velocity at the center of the entrance is less than it is farther down the tube. But, more important, fluid velocity near the wall is much greater than at the center, producing higher shear-rates and requiring greater than normal pressure gradients. It is customary to express the distance to establish a well-developed velocity profile in terms of tube diameters. From a theoretical analysis for Newtonian fluids,² length necessary to establish a well-developed profile is $L_e = 0.029 N_{Re}D$. However, experimental results³ indicate that this value is about equal to $0.05 N_{Re}D$. For non-Newtonian pseudoplastic materials, L_e appears to be in the range of 0.03 to $0.05 N'_{Re}D$.

Entrance effect is actually equivalent to an increase in effective length of the tube. For Newtonian materials, this additional length has been evaluated at 0.284, 0.402, and 0.412 diameters.⁴ It has been suggested that for L/D of greater than 65, entrance effect is negligible.⁵ With non-Newtonian fluids, the velocity profile is usually flatter than in Newtonian fluids, so the effect would be less. For the 12-in. tubes used in this study, the $\frac{1}{8}$ -in.-dia. tube has an L/D of about 200 and the $\frac{3}{8}$ -in. tube about 100.

Correcting for Pressure Losses

There are also pressure losses at the tube entrance due to kinetic-energy changes. Much of this loss occurs in the region just upstream of the entrance of the tube as the slow moving liquid in the reservoir accelerates to the entering velocity.

This loss is expressed as $m \rho V^2/g_c$, in lb./sq. ft. The constant m has been variously evaluated from 0.50 to 1.55.⁶ However, for Newtonian fluids, 1.12 is usually accepted.⁶ For non-Newtonian fluids, a value of $1.5 \rho V^2/g_c$ has been suggested, but experimental results seem to show that a value of $1.0 \rho V^2/g_c$ is probably more suitable.⁷ A very complete analysis of the problem has been presented by Bouge.⁸ All of these considerations have been based on sudden contractions. Actually, the rheometer used in this study has a Borda entrance with slightly higher entrance pressure drops.

End Effects Usually Negligible

End effects will always be present in extrusion rheometers. To minimize these, the L/D of the tubes used should be as large as practical.

The best and most accurate way of determining the magnitude of the losses is by experimentation. This is done by obtaining pressure-drop vs. flow-rate data for tubes of various lengths (but same diameter). Pres-

sure-drop values are taken from smooth curves of various tube lengths at a specific flow rate, and plotted against the tube length. The total end effect in terms of "equivalent" tube length can be obtained by extrapolation of the data to zero pressure drop. In general, with viscous materials, this loss is negligible if the L/D is kept high enough.

If entrance losses are ignored, the pipeflow charts will tend to be on the conservative side.

Check Against Bureau Standard

There is one last point to consider. The extrusion rheometer must be checked against a Newtonian fluid of known viscosity. Such materials are available from the National Bureau of Standards in Washington.⁹

Fluids are supplied in a number of viscosities with accurate data on the viscosity at various temperatures. If a semi-logarithmic plot is made of these viscosities (on the log scale) against the reciprocal absolute temperature (on the arithmetic scale), a straight line develops and the viscosity at any temperature may be determined.

If the procedure outlined above has been followed carefully, the extrusion rheometer should yield the standard viscosity precisely. Such a check is absolutely necessary to indicate that no errors have been made. There is one problem: Bureau fluids are only supplied in one-pint quantities. A much larger quantity is required for the rheometer outlined here, so another viscous oil should be used. This oil must be checked against a rotational viscometer calibrated with the Bureau fluid.

Nomenclature

D	Pipe or tube diameter, ft.
g_c	Gravitational constant, 32.2 (ft./sec.)/(sec.)
N_{Re}	Conventional Reynolds number (dimensionless), $DV\rho/\mu$
L	Pipe or tube length, ft.
ΔP	Pressure drop, lb./sq. ft.
Δp	Pressure drop, psi.
q	Flow rate, cu. ft./sec.
V	Mean linear velocity, ft./sec.
dv/dr	Local velocity gradient or rate of shear in pipeline or in a rotational viscometer, sec. ⁻¹ .
ρ	Density, lb./cu. ft.
τ	Shear stress, lb./sq. ft.
μ	Viscosity of a Newtonian fluid, lb./(sec.)(ft.)

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Although the McCabe-Thiele design method is widely used by chemical engineers for distillation problems, it may be useful to try another viewpoint. An alternate view is provided by cascade theory, and its usefulness extends to several practical areas: e.g., determining how old equipment can be used in new service and minimizing investment in multiple units.

Applying Cascade Theory in Distillation

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For binary distillation calculations, the McCabe-Thiele graphical method is well-known by most chemical engineers. Recently reviewed in the CE Refresher,¹ it was originally presented over 35 years ago.² Only a few simplifying assumptions are made in the familiar graphical method, chief of which is an assumption of constant molal liquid and vapor rates in the tower.

An alternative view—the cascade theory of separational processes—removes McCabe-Thiele's principal restriction. While increasing our understanding of standard procedures, cascade theory is also a useful tool for optimizing multiple-unit installations.

Fully described in Cohen³ and Benedict & Pigford,⁴ cascade theory was extensively developed for isotope separations.

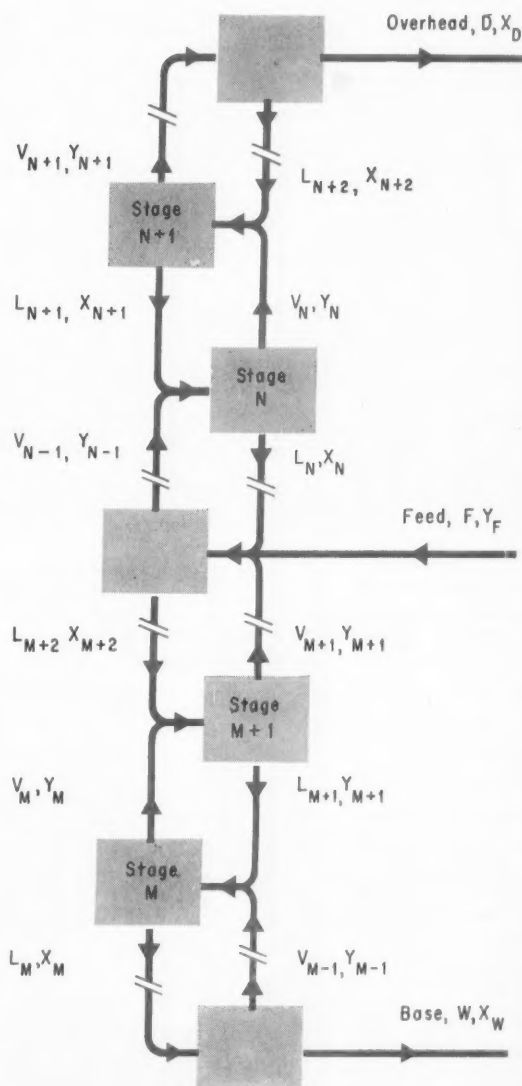
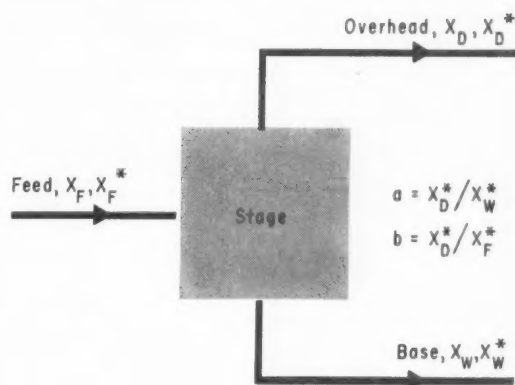
A few definitions facilitate exposition of the analysis. If concentrations are expressed as mole fraction ratios (indicated by an asterisk), the derived equations will be simplified, e.g.,

$$Y_N^* = Y_N / (1 - Y_N)$$

In equilibrium separation, any single step that effects some separation is a separating unit. Single units, such as a tray, or units of low capacity joined in parallel, constitute a stage.

At upper right, a single stage is diagrammed. Lower portion of the diagram shows how series-connected stages—a separation cascade—represent a tower.

The stage separation factor α is the concentration ratio in the overhead stream divided by the concentration in the base stream. (This is synonymous with relative volatility.) If the concentration ratio in the



overhead is divided by feedstream concentration ratio, the heads separation factor b results.

For the separation cascade, operating-line equations may be derived readily from mass balances. For the enriching section,

$$(Y_N - X_{N+1})/(X_D - Y_N) = D/L_{N+1}$$

For the stripping section,

$$(X_{M+1} - Y_M)/(X_W - Y_M) = W/L_{M+1}$$

At total reflux,

$$Y_N = X_{N+1}$$

and

$$Y_N^* = aX_N^* = aY_{N+1}^*$$

From this last relation, the Fenske equation⁷ can be derived. In terms of concentration ratios, it is

$$X_D^*/X_W^* = a^N$$

At total reflux, the separation achieved by a single stage between the entering and leaving vapor streams is a maximum. As product drawoff rate is increased, separation is reduced and becomes zero at minimum reflux. Under this latter condition,

$$Y_{N+1} = Y_N$$

From the definition of a ,

$$Y_N - X_{N+1} = Y_N(1 - a)(1 - Y_N)/[Y_N + a(1 - Y_N)]$$

Solving with the equation of the enriching operating line,

$$(L_{N+1}/D)_{\min} = (X_D - Y_N)[Y_N + a(1 - Y_N)]/Y_N(a - 1)(1 - Y_N)$$

or in terms of liquid composition,

$$(L_{N+1}/D)_{\min} = [X_D(aX_{N+1} + 1 - X_{N+1}) - aX_{N+1}]/(a - 1)X_{N+1}(1 - X_{N+1})$$

If the feed composition is substituted for Y_N or X_{N+1} (for vapor or liquid feed), these equations for minimum reflux are identical with those determined from the McCabe-Thiele plot. Minimum reflux on the McCabe-Thiele plot is minimum only at the feed tray. As the composition approaches the product and waste compositions, the minimum reflux decreases to zero at these points.

In the standard adiabatically operated tower, heat is added or removed only at the base and top, resulting in constant reflux ratio throughout the tower. Though this of necessity must be greater than the minimum reflux at the feed tray, the result is rapidly increasing reflux factors (operating reflux/minimum reflux) as the ends of the tower are approached.

An inspection of plots of reflux factor vs. plate factor^{8,9} shows that very high reflux factors are of marginal benefit in making a separation. Usually, however, this approach is more economic than adding and subtracting heat at intermediate points and reducing tower diameter at each end.

For the case of difficult separations, the savings in equipment cost and the reduction of in-process inventory can be made significant by "tapering" the cascade. It is interesting to determine, for the ideal case, how much interstage vapor and liquid can be reduced.

In the ideal cascade, head is added to all trays below the feed, and subtracted from those above. The following conditions hold when total interstage flows are minimum:

- Heads separation factor b is constant.
- Vapor and liquid fed to each stage have the same composition.

Under these conditions,

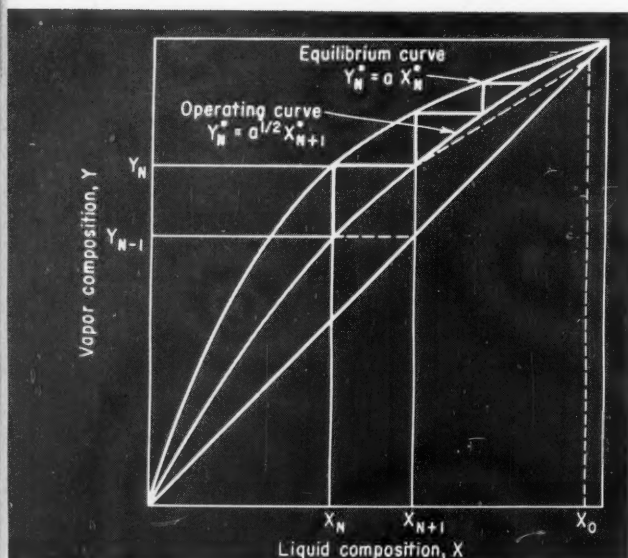
$$Y_{N+1}^* = bY_N^* = b^2X_{N+1}^* = aX_{N+1}^*$$

and

$$b = a^{1/2}$$

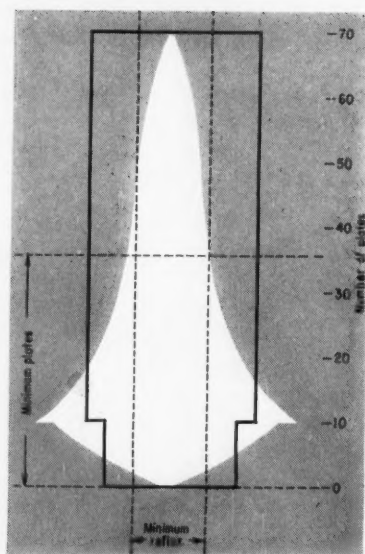
The equation of the operating line is, therefore,

$$Y_N^* = a^{1/2}X_{N+1}^*$$



Well-known plot of McCabe-Thiele (above) is used to show cascade theory relations. — (Fig. 2)

Ideally tapered tower (right) is compared with a standard installation.—(Fig. 3)



This equation, and that of the equilibrium curve,

$$Y_N^* = aX_N^*$$

are plotted on Fig. 2. As required, the geometry of the plot shows that $Y_{N-1} = X_{N+1}$. The reflux ratio at any point that minimizes total interstage flow can be derived as

$$(L_{N+1}/D)_{opt} = (X_D - Y_N)[Y_N + b(1 - Y_N)] / Y_N(b - 1)(1 - Y_N)$$

The equation for optimum reflux is, then, the same as that for minimum reflux, with a^3 or b replacing a .

In a method similar to that used to derive the Fenske equation, the optimum number of stages is determined to be

$$N_{opt} = [\ln(X_D^*/X_W^*) - 1] / \ln b$$

Thus, the optimum plate factor is close to 2.

Other relations between compositions, stage number, and vapor and liquid flows can be derived. Vapor flow in the enriching section as a function of stage number is

$$V_N = D + \left(\frac{D}{b-1} \right) X_D(1 - b^{N-i}) + (1 - X_D)b(b^{i-N} - 1)$$

where i is total number of stages. Similarly, vapor rate in the stripping section is

$$V_N = \left(\frac{W}{b-1} \right) bX_W(b^N - 1) + (1 - X_W)(1 - b^{-N})$$

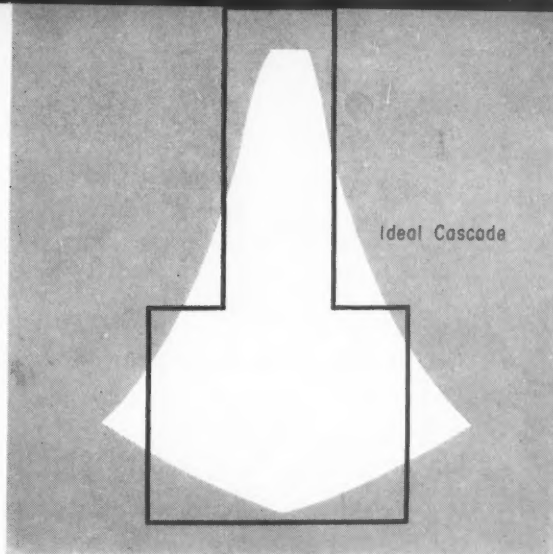
To compare an ideally tapered tower with a standard installation, consider a separation of two materials in which relative volatility a is 1.21. Assume feed, product and base compositions are 25, 99 and 10 mole percent, respectively.

Possible combinations of trays and reflux are plotted in Fig. 3. On the vertical axis, number of trays is plotted vs. vapor flow on the horizontal axis. Total vapor flow is represented by the area of the plot. Both minimum reflux and minimum plates require infinite total vapor flow, but the design case, of course, falls between these extremes.

Happel⁸ has outlined a rapid method for determining the optimum economic balance. In most cases, the optimum reflux ratio is close to minimum, because over the life of the tower, the cost of heat transferred far outweighs material cost. Because of unreliable volatility data, control problems or tray hydraulics at low liquid flows, however, towers are not normally designed at the optimum economic point. Fairly common are reflux factors of 1.2 to 1.6.

A standard "straight" column, designed at a reflux factor of 1.2, is plotted in Fig. 3, along with the curved outline of the ideal cascade for the same separation. Characteristic of the ideal cascade are high vapor rates at the feed point that decrease markedly at both ends of the tower. In such a tower, total vapor flow is less than 60% that required by the standard installation.

As mentioned before, it is seldom economic to add or subtract heat at other than tower top or base, and reduce diameter at both ends, for a single unit. But tall towers are expensive to erect, and upper trays can be placed in a second smaller shell with little effect on the separation.



Ideal cascade, shown in white cutout above, can be used to choose the balance of trays between two towers.—(Fig. 4)

For difficult separations, where multiple units are involved, cascade theory can be used to minimize investment. It can also be used to determine how existing equipment can best be used in a new service. By calculating vapor rate at various stages for an ideal cascade, the optimum points at which to square off the cascade into individual units (operating at constant reflux ratio) can be more rapidly determined.

Consider, for example, an installation where two towers are to be used to separate a feedstream into two relatively pure products. The ideal cascade might appear as in Fig. 4. For the two-tower system, vapor rates and plate requirements can be compared with the ideal as shown. Such comparison will frequently show that the addition of a few plates to one tower will considerably reduce the other's diameter.

The same principle—interrelating feed and product compositions, vapor rates and tray requirements—can be used to optimize product recoveries in units separating a multicomponent mixture, but the mathematics are not so precise. The ideal cascade, however, can be used as a design criterion in distillation or any other equilibrium separation process.

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Modern Transport Phenomena Can

Even more fundamental to industrial processes than the classification of unit operations is a set of underlying principles of engineering. Just as the unit operations were evolved to unify and simplify the study of industrial processes, a set of principles called transport phenomena is being developed today to unify the study of unit operations while giving greater insight into the fundamentals.

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Transport phenomena are the combined study of the basic fundamentals of momentum transport, energy transport and mass transport, which represent fluid flow, heat transfer and mass transfer, respectively. They are as basically related to the rate studies of unit operations as kinetics is to rates of reaction in unit processes, or as thermodynamics is to the study of equilibrium processes. Yet, engineers have only recently recognized this fact.

Frequently, the behavior of an operation will depend on more than one of these phenomena. For example, fluid flow, mass transfer and heat transfer are seen to be important in distillation; and both mass transfer and heat transfer have been shown to influence the rate of drying.

Analogy in Molecular Transport Equations

The question might be asked, "Why study mass, heat

and momentum transport as a unit? Why not study each separately, the way that heat transfer, fluid flow and mass transfer operations have been studied in the past?" The answers are simple. The basic fundamentals of mass, heat and momentum transfer are so similar to one another that a combined study not only conserves effort but also contributes to greater understanding of these basic principles. In addition, since combined heat, mass and momentum transport occur simultaneously in many operations, a study of these phenomena as a unit seems all the more essential if the entire process is to be completely understood.

The analogy among the basic principles of heat, mass and momentum transport can be demonstrated as shown in Table I, wherein traditional rate equations for heat transfer (Fourier's law), mass transfer (Fick's first law) and fluid flow (Newton's law) are compared to each other. It is interesting to observe that each of these well-known laws can be reduced to an equation:

$$(\text{Flux of property}) = - (\text{Diffusivity}) \times (\text{Gradient of concentration of property}) \quad (1)$$

where the units for each term are identical when considering the property being transferred. Property is used as a general term meaning quantity of heat or mass or momentum.

Units for the flux of property are: property transferred/(hr.) (sq. ft.) in every case where the property units of heat, mass and momentum are Btu., lb. and (lb.) (ft.)/hr., respectively. Units for the diffusivity of property are: sq. ft./hr. in each case.* Units for the concentration of property are: property/cu. ft. For example, the concentration of mass is: lb./cu. ft., and that of momentum is: (lb.) (ft.)/(hr.) (cu. ft.). Therefore, each of these classic equations describing molecular transport of heat, mass and momentum can be represented by a single equation.

General Equations of Change

The analogy shown in Table I is only for steady-state molecular transport of the property in a single direction. The questions may well be asked: "Does this close analogy still hold if the transport of property occurs by means other than molecular motion? What happens for the unsteady state case? How about the case where transfer of a property occurs in more than one direction?"

* Methods of estimating α , the thermal diffusivity; D , the molecular diffusivity; and ν , the viscous diffusivity (kinematic viscosity) will be considered in a future issue. These diffusivities are termed "transport coefficients."

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Unify Basic Transfer Theories

Table II shows such a comparison, wherein the traditional equations of conservation (often referred to as the general equation of change) of heat, mass and momentum are shown using Cartesian coordinates for the somewhat simplified cases indicated. Again, many similarities can be observed among these equations, each of which can be represented in the form:

$$\left\{ \begin{array}{l} \text{Net rate of} \\ \text{accumulation} \\ \text{of property in} \\ \text{volume element} \end{array} \right\} = \left\{ \begin{array}{l} \text{Rate of generation} \\ \text{of property in} \\ \text{volume element} \end{array} \right\} - \left\{ \begin{array}{l} \text{Net rate of transfer} \\ \text{of property by con-} \\ \text{vection (flow) across} \\ \text{element surface} \end{array} \right\} - \left\{ \begin{array}{l} \text{Net rate of transfer of} \\ \text{property by molecular} \\ \text{motion across element} \\ \text{surface} \end{array} \right\} \quad (2)$$

Each of the terms in a single column of Table II are very much alike. For example, the convection term of

Column 4 is a velocity times a rate of change of property with respect to distance (a gradient of property) for each of the x , y and z directions. The molecular motion term in Column 5 is a diffusivity times a second derivative with respect to distance of the property being transferred for each direction. The transport coefficients, α , D and ν , have the same meaning as in Table I.

The general equations shown in Table II have been simplified by assumptions of constant C_p , ρ , D_{AB} and μ . Therefore, changes in heat are represented as changes in temperature, and changes in momentum as changes in velocity.

Only the x component is shown for the momentum equation. Velocity is a vector quantity while temperature and concentration are scalar.

To form a meaningful analogy, only the scalar com-

Analogy in rate equations for heat, mass and momentum transfer by molecular motion—Table I

Property	Governing Law	Flux Property Transferred/ (Time)(Area)	Diffusivity (Length) ² /Time	Force Gradient of Concentration of Property
Heat	Fourier's Law (Conduction) $q = -\frac{k d(\rho C_p T)}{\rho C_p dx}$	Heat Flux q Btu./ (hr.)(sq.ft.)	Thermal Diffusivity $\frac{k}{\rho C_p}$ sq.ft./hr.	Temperature Gradient $\frac{d(\rho C_p T)}{dx}$ $d(\text{Btu./cu.ft.})/dx$
Mass	Fick's first law (Molecular diffusion) $J_A = \frac{D dC_A}{dx}$	Mass Flux J_A lb./ (hr.)(sq.ft.)	Molecular Diffusivity D sq.ft./hr.	Concentration Gradient $\frac{d(C_A)}{dx}$ $d(\text{lb./cu.ft.})/dx$
Momentum (mass \times velocity)	Newton's law (Viscous flow) $\tau_{vgc} = -\frac{\nu d(V\rho)}{dx}$	Momentum Flux τ_{vgc} (lb. ft./hr.)/(hr.)(sq.ft.)	Viscous Diffusivity $\nu = \mu/\rho$ sq.ft./hr.	Velocity Gradient $\frac{d(V\rho)}{dx}$ $d(\text{lb.})(\text{ft.})/(\text{hr.})(\text{cu.ft.})/dx$

Analogy in equations of change of heat, mass and momentum—Table II

	Rate of Change With Time	Generation (External forces)	Rate of Change by Convection (Flow)	Rate of Change by Molecular Motion
Heat (Constant C_p , ρ ; incompressible flow)	$\frac{\partial T}{\partial t}$	$\frac{Q}{\rho C_p}$	$\left(V_x \frac{\partial T}{\partial x} + V_y \frac{\partial T}{\partial y} + V_z \frac{\partial T}{\partial z} \right)$	$\alpha \left(\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} + \frac{\partial^2 T}{\partial z^2} \right)$
Mass (Constant ρ , D_{AB} ; binary system)	$\frac{\partial C_A}{\partial t}$	R_A	$\left(V_x \frac{\partial C_A}{\partial x} + V_y \frac{\partial C_A}{\partial y} + V_z \frac{\partial C_A}{\partial z} \right)$	$D_{AB} \left(\frac{\partial^2 C_A}{\partial x^2} + \frac{\partial^2 C_A}{\partial y^2} + \frac{\partial^2 C_A}{\partial z^2} \right)$
Momentum (Constant ρ , μ , x -component)	$\frac{\partial V_x}{\partial t}$	$-\frac{\partial p}{\partial x} + g_x$	$\left(V_x \frac{\partial V_x}{\partial x} + V_y \frac{\partial V_x}{\partial y} + V_z \frac{\partial V_x}{\partial z} \right)$	$\nu \left(\frac{\partial^2 V_x}{\partial x^2} + \frac{\partial^2 V_x}{\partial y^2} + \frac{\partial^2 V_x}{\partial z^2} \right)$

ponent v_x of the vector velocity V was considered in formulating the momentum equation in Table II. Therefore, it should be apparent that whereas many similarities exist among these equations, the analogy is not perfect. Remember that equations given in Table II are for special cases. More general equations of change have been presented in the literature.¹

The study of transport phenomena as a set of fundamental principles in chemical engineering is being developed partly as a result of these similarities in the mechanisms producing transfer of mass, heat and momentum. Such a study has been outlined in at least two new textbooks^{2,4} and is being taught at several universities prior to the study of unit operations. Indeed, transport phenomena already have found a place alongside stoichiometry, thermodynamics and kinetics in modern chemical engineering curricula.

Application of Transport Equations

Since the equations of change of a property being transported are general, they describe the phenomena occurring in an enormous number of specific cases where dynamic processes are involved, and therefore, give an excellent starting point for a theoretical approach to these problems.

Examples of this approach are continually appearing in the recent literature. Sterling and Scriven⁵ recently won the 1960 AIChE Colburn award for the paper, "Interfacial Turbulence: Hydrodynamic Instability and the Marangoni Effect." In this article, the authors solved the equation of change of momentum for a Newtonian fluid in the absence of body forces simultaneously with the equation of continuity of mass. This and other selected examples of many recent important papers that illustrate the use of transport equations in solving complex engineering problems are shown in Table III. Each of these examples illus-

trates this fundamental approach to the solution of complex engineering problems.

The following examples are given to illustrate the transport phenomena approach to the solution of problems in more detail.

In Heat Transfer Analysis

Consider the steady-state conduction of heat in a uniform solid. The general equation of conservation of energy as given in Table II is:

$$\frac{\partial T}{\partial t} = \frac{Q}{\rho C_p} - \left(V_x \frac{\partial T}{\partial x} + V_y \frac{\partial T}{\partial y} + V_z \frac{\partial T}{\partial z} \right) + \alpha \left(\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} + \frac{\partial^2 T}{\partial z^2} \right) \quad (3)$$

Note that the following terms cancel from Eq. (3) for the reason given:

$$\left. \begin{array}{l} \text{Steady state: } \frac{\partial T}{\partial t} = 0 \\ \text{No generation: } \frac{Q}{\rho C_p} = 0 \\ \text{No convection: } (V_x, V_y, V_z) = 0 \end{array} \right\} \quad (4)$$

The resulting equation is the well-known Laplace equation whose classical solution⁶ has long been known:

$$0 = \frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} + \frac{\partial^2 T}{\partial z^2} \quad (5)$$

It is interesting to note the ease with which Eq. (5) was derived when compared with the task of writing a differential heat balance in three dimensions using the Fourier equation.

In Mass Transfer Analysis

In this example, unidirectional countercurrent laminar flow of a gas and a liquid is considered in an absorption column where a solute is being absorbed from the gas to the liquid in steady-state fashion.

The equation of conservation of mass can be written as follows for the liquid (x) phase:

$$\frac{\partial C_z}{\partial t} = - \left(V_z \frac{\partial C_z}{\partial x} + V_y \frac{\partial C_z}{\partial y} + V_s \frac{\partial C_z}{\partial z} \right) + D \left(\frac{\partial^2 C_z}{\partial x^2} + \frac{\partial^2 C_z}{\partial y^2} + \frac{\partial^2 C_z}{\partial z^2} \right) + \phi \quad (6)$$

where ϕ represents the net amount of solute being absorbed across the interfacial surface of a differential element.

According to the specifications of the problem, the following terms become:

$$\left. \begin{array}{l} \text{Steady state: } \partial C_z / \partial t = 0 \\ \text{Unidirectional flow in the } z\text{-direction: } (V_x, V_y) = 0 \\ \text{Transport of mass by molecular diffusion negligible for liquids, compared with other mechanisms: } D \approx 0 \\ \text{Assume two-film theory describes interphasal transfer.} \end{array} \right\} \quad (7)$$

Hence:

$$\phi = K_s a (C_s^* - C_s)$$

After eliminating the terms that equal zero and substituting the value for ϕ , Eq. (6) becomes:

$$0 = - V_s \frac{dC_s}{dz} + K_s a (C_s^* - C_s) \quad (8)$$

Eq. (8) can be rearranged to yield the familiar design equation in mass transfer operations:

$$h = \frac{V}{K_s a} \int_{C_{s1}}^{C_{s2}} \frac{dC_s}{C_s^* - C_s} = (HTU_{ss})(NTU_{ss}) \quad (9)$$

A definite advantage of deriving a relationship using the transport phenomena approach is that assumptions that are made in the derivation are more apparent. For example, the assumption of neglecting effects of intraphasial molecular diffusion becomes apparent in the derivation of Eq. (9).

In Momentum Transfer Analysis

Consider steady-state laminar flow of an incompressible Newtonian fluid in a very long tube of length L and uniform radius R .

The basic equation of momentum shown in Table II can be represented in cylindrical coordinates for the

Transport equations provide solutions to complex engineering problems—Table III

Recent Examples	Approach	Ref.
Interfacial Turbulence: Hydrodynamic Instability and the Marangoni Effect	Solved equation of change of momentum for Newtonian fluid, in absence of body forces, simultaneously with equation of continuity of mass.	11
Theoretical Explanation of Heat Transfer in Laminar Flow	Used simplified form of equation of conservation of energy in cylindrical coordinates.	6
The Transition from Free to Forced Convection in Mass Transfer from Solid Spheres	Started with modified forms of the equations of change of mass and momentum using assumptions of boundary layer theory.	5
Axial Mixing and Extraction Efficiency	Investigated theoretically effects of longitudinal mixing on the separation efficiency of an extraction column by solving simultaneously the equations of conservation of mass written for the two immiscible phases present.	10
Transition from Laminar to Turbulent Flow in Pipes	Applied momentum transport equations in two dimensions for a fluid on which no body forces act.	9
Unsteady Multicomponent Diffusional Evaporation	Solved the n equations of continuity of mass for an n -component system using the Stefan-Maxwell equations to describe the interrelation of molecular fluxes with concentration gradients.	7
Macroscopic Mixing in Fluidization	Theoretical basis was reduced form of equation of change of mass in cylindrical coordinates for the steady state case where a turbulent form of Fick's second law was assumed to represent eddy diffusion.	3
Heat or Mass Transfer in a Fluid in Laminar Flow in Circular or Flat Conduit.	Accurate solution of steady state equation of change of heat for unidirectional flow in cylindrical cartesian coordinates was presented.	2

Future articles in this new CE Refresher series will include:

- General equations for transport phenomena
- Prediction of transport coefficients
- Solving complex engineering problems

z -component and results in the following equation:

$$\frac{\partial V_z}{\partial t} = \frac{1}{\rho} \frac{\partial P}{\partial z} + g_z - \left(V_r \frac{\partial V_z}{\partial r} + \frac{V_\theta}{r} \frac{\partial V_z}{\partial \theta} + V_z \frac{\partial V_z}{\partial z} \right) + \left[\frac{1}{r} \frac{\partial}{\partial r} \left(r \frac{\partial V_z}{\partial r} \right) + \frac{1}{r^2} \frac{\partial^2 V_z}{\partial \theta^2} + \frac{\partial^2 V_z}{\partial z^2} \right] \quad (10)$$

According to the specifications of the problem, the following terms in Eq. (10) become zero:

Steady state: $\partial V_z / \partial t = 0$

Unidirectional flow: $(V_r, V_\theta) = 0$

Constant diameter pipe, incompressible fluid:

$$\partial V_z / \partial z = 0$$

No gravitational attraction in direction of flow for horizontal pipe: $g_z = 0$

Making the simplifications indicated in Eqs. (11), Eq. (10) becomes:

$$\frac{\partial P}{\partial z} = \mu \left[\frac{1}{r} \frac{\partial}{\partial r} \left(r \frac{\partial V_z}{\partial r} \right) \right] \quad (12)$$

Eq. (12) is the basic differential equation whose solution leads to the classical Hagen-Poiseuille law for laminar flow of Newtonian fluids in cylindrical ducts:

$$P = 32V\mu L / g_c D^2 \quad (13)$$

The prime purpose of these examples has not been to indicate easier methods of deriving classical equations such as Eq. (13) but rather to show the wide applicability of the general equations of change using well-known cases. It is easy to see that the governing differential equations for many complex problems can be just as easily obtained by an analogous procedure.

Since the advent of analog and digital computers, solutions to differential equations of a more complex nature have been made possible. Articles are continually being published on numerical and analytical solutions to partial differential equations.

In the future, engineers with a background of fundamental engineering principles such as transport phenomena, kinetics and thermodynamics, and with computers as a tool, will be able to provide theoretical solutions to many of the complex engineering problems they have been unable to solve in the past.

Chemical engineering will continue to see more emphasis on this approach in the future with trans-

port phenomena becoming as commonplace to the engineer as thermodynamics is today.

Nomenclature

C	Concentration, lb./cu.ft.
C_x	Concentration in x -phase, lb./cu.ft.
C_y	Concentration in y -phase that would be in equilibrium with y -phase, lb./cu.ft.
C_p	Heat capacity, Btu./(lb.) (°F.).
d	Pipe diameter, ft.
D	Diffusivity, sq.ft./hr.
D_{AB}	Diffusivity of A in B , sq.ft./hr.
g	Acceleration of gravity, ft./hr. ²
g_c	Gravitational constant, lb.-ft./(lb. _r) (hr. ²).
h	Column height, ft.
HTU_{ox}	Over-all height of a transfer unit based on x -phase, ft.
J	Flux of mass, lb./ (hr.) (sq.ft.).
k	Thermal conductivity, Btu./ (hr.) (sq.ft.) (°F./ft.).
$K_x a$	Mass transfer coefficient multiplied by interfacial area, 1/hr.
NTU_{ox}	Over-all number of transfer units based on x -phase.
P	Pressure, lb. _r /sq.ft.
ΔP	Pressure drop, lb. _r /sq.ft.
Q	Rate of generation of heat per unit volume.
q	Heat flux, Btu./ (hr.) (sq.ft.).
R	Rate of generation of mass per unit volume, lb./ (hr.) (cu.ft.).
r	Cylindrical coordinate in direction of radius, ft.
t	Time, hr.
T	Absolute temperature, °R.
v	Scalar velocity component, ft./hr.
V	Vector velocity, ft./hr.
x, y, z	Cartesian coordinates, ft.
α	Thermal diffusivity, sq.ft./hr.
θ	Cylindrical coordinate, radians.
μ	Viscosity, lb./ (ft.) (hr.).
ν	Viscous diffusivity (kinematic viscosity), sq.ft./hr.
ρ	Density, lb./cu.ft.
τ_y	Shear stress perpendicular to flow, lb. _r /sq.ft.
ϕ	Rate of interphasial mass transfer per unit volume, lb./ (hr.) (cu.ft.).

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Meet the Author

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Engineering Observers Tell of Russian Visit

EJC team toured U.S.S.R. last year to gain impression of engineers' education and use.

Russia has nearly 30% more engineers than the United States, and last year graduated three times as many of them as did the U.S. So discovered a delegation of engineering representatives, headed by chemical engineer Walter Lobo, that toured U.S.S.R. facilities last year under a cultural exchange agreement.

By no means a comprehensive look (the team visited no process industry plants, for example), the group's report* still offers provocative checkpoints of Russia's continuing economic climb. Among its points, the report states that

- Quality of engineering education is as good or better than that of U.S. undergraduate training—at least in those institutes visited.

- Cooperative industry-engineering school education is the rule, rather than the exception.

- Manpower planning, unguided by market supply and demand, has led to discipline imbalances in the past. Under a new method of planning, which still hasn't had time to shake down, economic needs of the next two decades will determine engineers' training and allocation.

- Continuing education on a part-time basis is state-encouraged and well accepted by individuals in industrial positions.

Incentives Under Socialism

Just as youngsters in this country seek the financial return, community prestige and other rewards of the professions, so do they in Russia. But the team verified what has seemed apparent—that such incentives as pay and housing are awarded on an extremely preferential basis, and prestige of certain professions towers above that of the same professions in the U.S.

Starting salaries of diploma engineering graduates ranged, in 1960, from 800 to 1,200 rubles at a time when the official exchange rate was four rubles to the dollar. Buying goods in Moscow, however, the team found that 10:1 gave a better measurement of purchasing power when converting to dollars.

After five years of experience, most engineers earn 2,000 rubles/mo., with a range of 1,500 to 3,000. In

remote areas there may be "hardship" increments of good size. Too, if the enterprise which employs the engineer meets or exceeds its annual goal, bonuses may be added to his pay.

Because of the state planning of jobs, and the incentives attached to those in engineering and science, students tend to seek places in the universities for the necessary training. Not only do they have the future rewards in mind, but also the stipends they receive while in school. The U.S. delegation found, for example, that at one institute, students of mining engineering received 350 rubles/mo. in their first year, 400 in their second, 450 in the next two years and 480 rubles/mo. in the fifth year. Those with top grades received an increment of 25% above the amounts indicated.

Substitute for Spring Recruiting

Though there is no legal compulsion (there once was), political pressure channels most graduates into jobs the state assigns. The closest the Russians come to our annual marathon recruiting in the colleges is when alumni in industry write back to their alma maters asking for graduates, thus trying to short-circuit the state-planned distribution. These requests are simply funneled into the official placement plan.

Distribution is handled by first asking the students' preferences, then attempting to match preferences to available vacancies, finally "offering" jobs to the students individually. About 70% of the students in full-time schools are placed in this first go-around, most others find jobs to their liking in later adjustments. Very few—"five or six in a graduating class of 1,600," said one institute officer—are unhappy about assignments. Those who are can later apply for a transfer.

Though it is the most important source of new engineers, the distribution system of the day institutes isn't the sole source of new engineers. The Soviets encourage part-time evening and correspondence instruction for workers by, among other things, giving liberal free time off for exam studying and thesis writing. In this area, as in the others cited, the U.S. can learn how government spending, prodding and planning helps meet indicated manpower shortages.

* "The Training, Placement and Utilization of Engineers and Technicians in the Soviet Union." Engineers Joint Council, 29 W. 39th St., New York 18. \$1.

Here is how NSPE and EJC 1960 salary figures compare . . .

Year of Entry ▶		'20-'24*	'25-'29	'30-'34	'35-'39	'47-'48	1953	1954	1955	1956	1957	1958	1959	1960
Lower decile	NSPE	8,570	8,540	8,640	8,750	8,180	7,080	6,960	6,670	6,510	6,160	5,820	5,510	3,000
	EJC	8,800	9,000	8,775	9,000	8,500	7,325	7,100	6,925	6,700	6,550	6,250	6,050	5,775
Lower quartile	NSPE	10,410	10,320	10,320	10,410	9,380	7,760	7,560	7,330	7,090	6,730	6,390	5,960	3,590
	EJC	10,450	10,575	10,275	10,500	9,500	8,025	7,725	7,500	7,225	7,000	6,700	6,350	6,100
Median	NSPE	13,130	12,610	12,240	12,460	10,840	8,720	8,460	8,230	7,730	7,400	6,980	6,530	5,510
	EJC	12,950	12,775	12,575	12,875	10,875	9,000	8,550	8,200	7,875	7,600	7,225	6,775	6,350
Upper quartile	NSPE	18,800	17,460	16,960	16,970	13,030	10,030	9,600	9,400	8,800	8,210	7,510	7,210	6,480
	EJC	16,825	16,250	15,775	15,675	12,650	9,950	9,575	9,150	8,650	8,175	7,775	7,275	6,725
Upper decile	NSPE	29,230	25,900	25,680	24,490	16,570	11,800	11,140	10,830	10,470	9,170	8,390	8,040	7,950
	EJC	24,250	22,150	21,025	19,550	14,575	11,150	10,725	10,150	9,475	8,850	8,325	7,850	7,250

* EJC figures here are for all respondents who entered before or in 1924.

PROFESSIONAL ENGINEERS STAND TALL ON PAY SCALE

Study shows license advantage is best at upper reaches of engineers' salary scale.

In the fifth biennial survey of its members' salaries and fees,* National Society of Professional Engineers has provided a profile of the licensed engineer's pay standing in 1960. Since, once more, the survey year coincides with that of the Engineers Joint Council study of all engineers' pay (*Chem. Eng.*, Mar. 20, p. 172), it's instructive to compare the two (above).

The two studies aren't strictly comparable. In the EJC study, for example, employers report the salary data. In NSPE's study, the individual engineer fills out the questionnaire. Though some cynics hold that the latter technique leads to inflated figures, the survey results don't bear that out. Figures for NSPE members aren't greatly different from those of EJC for younger ages and lower parts of the pay scale where such exaggeration would most likely occur.

Another difference in the studies is the way that the over-all figures are further broken down. While EJC groups according to industry segments (chemical, petroleum, railroads, etc.), NSPE uses engineering branch.

Outstanding point that emerges upon studying the two surveys is that the professional engineering license means extra dollars at the higher parts of the pay scale, no matter what the year of entry into the profession. This holds whether comparing EJC's "all activities, all graduates" category or, as we have here, comparing EJC's "all industries, all graduates" category with the NSPE data.

In the comparison above, however, the differential reverses itself at median and lower levels. The EJC figures then lead in almost all years of entry.

Here's how branches fared . . .

	1960 Median Income by Branch					
	'20-'24	'30-'34	'47-'48	1956	1958	1960
Chemical	15,500	15,680	11,410	*	*	*
Electrical	14,500	12,240	10,940	8,370	7,320	6,190
Mechanical	13,960	13,730	11,020	8,070	7,070	5,710
Petroleum	21,000	16,920	11,560	7,350	*	*
Median of all	13,130	12,240	10,840	7,730	6,980	5,510

* Indicates fewer than 20 respondents.

Here's job function of respondents . . .

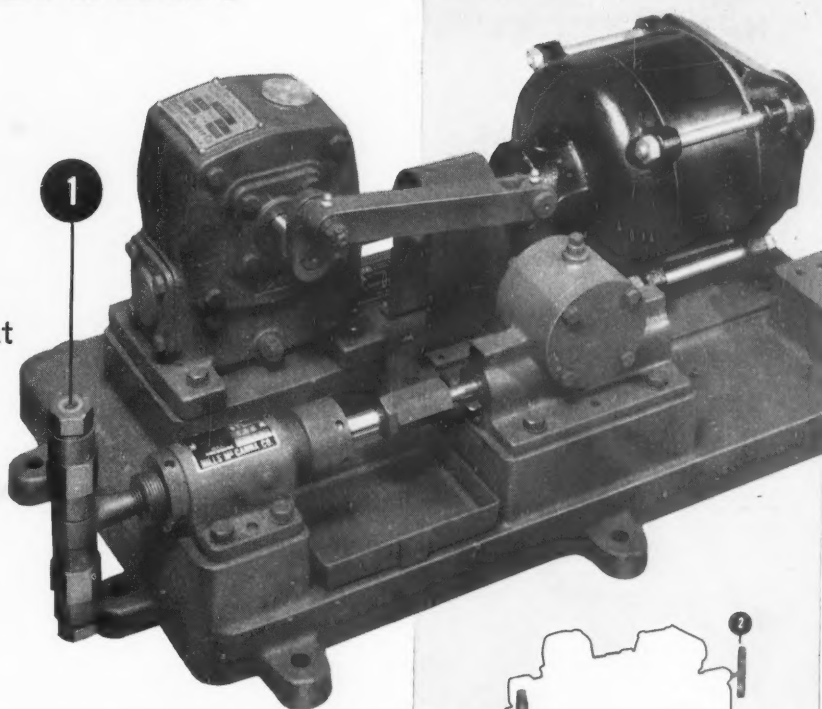
	Percent of Respondents in Each Function					
	'20-'24	'30-'34	'47-'48	1956	1958	1960
Exec-Admin.	46	45	26	6	4	3
Design	13	16	25	40	40	32
Prod. & Maint.	4	6	8	13	15	19
R & D	6	5	8	14	13	17
Constr. Superv.	8	8	8	11	15	13

* "Professional Engineers' Income & Salary Survey—1960," National Society of Professional Engineers, 2029 K St., Washington 6, D. C. \$2.

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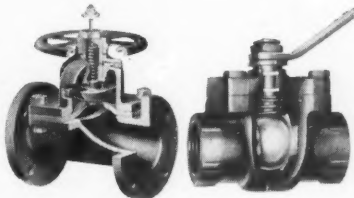
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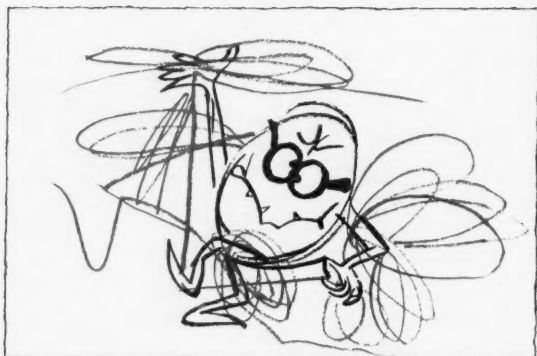
... or a second, third, or fourth feed can be added to a pump by using a four-feed base



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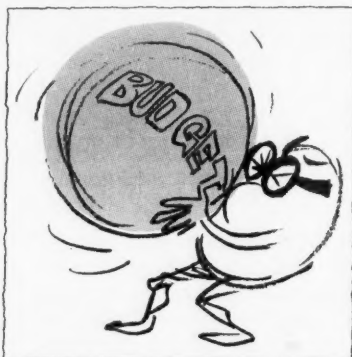
BE QUICK TO SEIZE THE PROBLEM . . . Never query its validity; this can be construed as a negative, noncreative attitude. Don't evaluate all the possibilities; you will be considered academic by your associates and a dreamer by your supervisor. Seize the ball and run with it; speed counts, not direction.



BEWARE OF THE SIMPLE SOLUTION, ESPECIALLY IN PRESENTATION . . . Make it look difficult. If it's simple, any fool could have done it, and it lowers your professional standing. Also your associates will resent you for giving the game away.



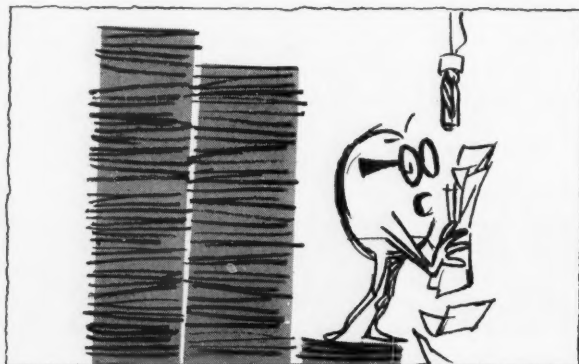
IF YOUR COMPANY SENDS YOU TO A CONFERENCE . . . make some good employment contacts. Your company appreciates men who take advantage of opportunity . . . they wouldn't want you to miss one.



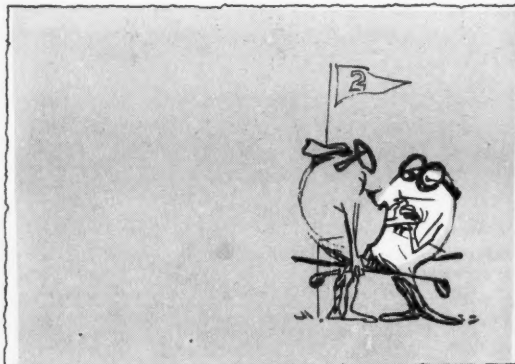
ON PREPARING BUDGETS . . . When you submit a budget, multiply it by four. Your comptroller can then cut it in two, and still leave you two up, which is twice as good as being only one up.



REMEMBER, THE BEST IDEAS ORIGINATE IN THE U. S. . . Other people have to think and talk in a foreign language. This gives you a tremendous technical edge.

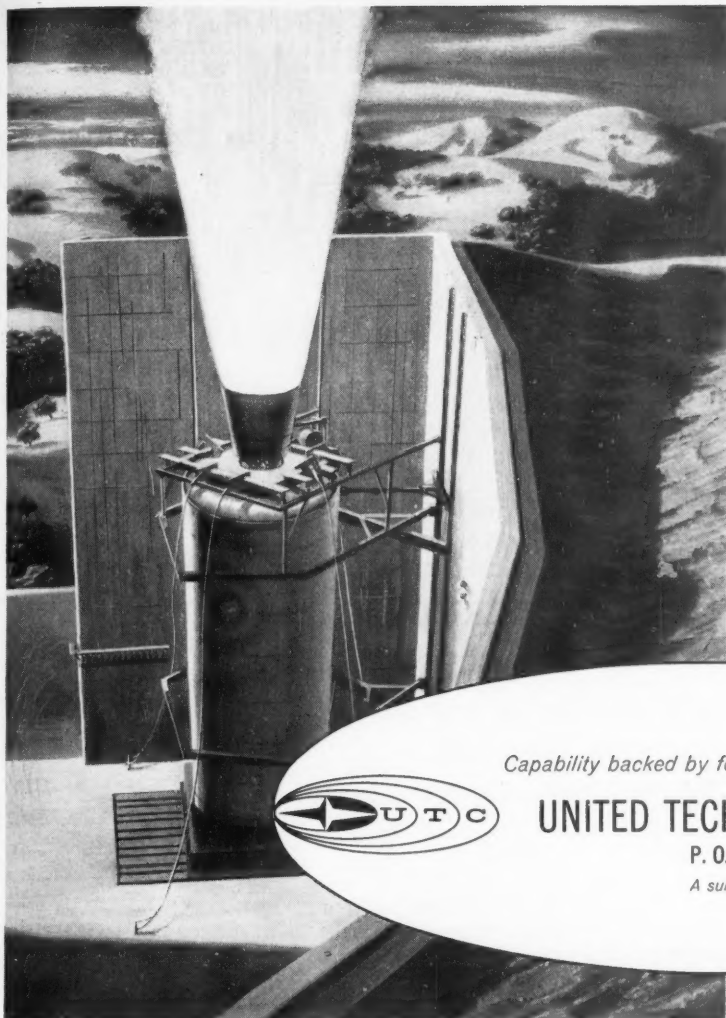


IF YOU'RE GOING TO GIVE A PAPER, READ IT . . . The audience could read it themselves four times faster, but it does them good to slow down a bit. Beware of abstracts. Never show your hand at the beginning . . . who would ever read a novel if told the plot?



MOVE INTO SALES OR MANAGEMENT . . . If you've mastered all of these principles thoroughly, you are now ready to move over into sales or management. Then you, too, can say, "I used to be an engineer."

Cartoons and text from "Engineersmanship" by Bernard Benson, Benson-Lehner Corp., Santa Monica, Calif., \$3. By permission.



Left: Test-firing of large, flight-weight solid propellant rockets at UTC Development Center is important phase of multi-million pound thrust booster development program.

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The CPI Looks at Equipment Leasing

- Does leasing have much to offer the chemical process industries?
- What type of chemical equipment can be leased?
- How much leasing is the CPI doing, and what is the trend?

HERBERT POPPER, Assistant Editor

"Sure our business has been increasing by 50% a year," M. Silverman, president of National Equipment Rental, Ltd., told the author, "but just like they say the best songs on Broadway haven't been composed or sung yet, so we feel that the best lease contracts haven't been written yet. But they will be." This optimism is echoed by many executives of leasing companies.

Actually equipment leasing as a technique, is quite old. (One of the earliest cases on record occurred in New York State back in 1845, when Schuylkill Navigation Co. bought transportation barges, to lease to operators.) There is also nothing new in a manufacturer like IBM offering some of its equipment for lease. Until 1952, however, no company specialized in leasing other people's equipment.

Since then, the growth of such leasing companies has been rapid, and they expect their volume to keep on zooming at an average rate of about 40% annually.

The chemical process industries were slower than some others in availing themselves of leasing services; however, at the present time, interest appears to be growing. For instance, Robert E. Sheridan, president of Nationwide Leasing Co. feels that from here on in, lease volume in the CPI will gain by 50 to 60% annually for the next five years, regardless of what happens with capital expenditures.

To find out more about this trend, we interviewed

many chemical equipment lessees and lessors. While some were more enthusiastic than others, most felt that there were good reasons why leasing would become considerably more popular in the CPI. Later on, we'll take a look at some of their reasons (and reservations).

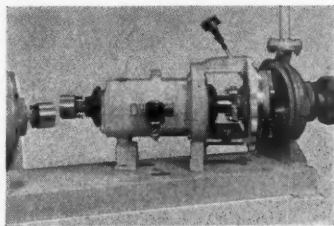
This article will concentrate on leasing rather than rentals, on equipment rather than vehicles. (Leasing usually implies a term of three years or longer; rentals are for shorter periods.) We will emphasize phases and developments of particular interest to the CPI. For a more basic discussion of leasing, we suggest "Sale-Leasebacks and Leasing," by H. Greenfield and F. Griesinger, McGraw-Hill, 1958.

How Much Equipment Was Leased in 1960?

Unimpeachable statistics are hard to come by. The breakdown below is a result of surveys made for Nationwide Leasing Co., and Wheels, Inc. It gives value of new leases written in 1960.

	Millions
Auto & truck fleets	
Leased by the CPI.....	\$228
Leased by other industries.....	\$1,310
Production, research & office equipment	
Leased by the CPI.....	\$132
Leased by other industries.....	\$398
Total	\$2,068

Some fundamentals of centrifugal pump design for the chemical process industries



The primary pump problems in the chemical industry involve materials of construction, gland and seal leakage, and bearing failure. Unless pumps are specifically designed for chemical service, unless materials of construction are selected to handle specific corrosive conditions, unless maintenance is simple and parts standardization is high your pumps may be the biggest headache in your entire operation.

Materials of construction

DURCO has spent 50 years developing alloys and materials for practically any corrosive service.

Pumps and pump parts are available in fourteen standard and many special corrosion resistant alloys. All of these are cast in the Durco foundry to retain complete responsibility for the excellence of your equipment.

Chlorimet 2	Ductile iron
Chlorimet 3	18-8-S (304 s.s.)
Durco D-10	18-8-S-Mo
Durichlor	(316 s.s.)
Duriron	Monel
Durimet 20	Nickel
Durcon (modified epoxy resin)	Ni-Resist #2 Inconel

Specific design for Chemical Service

Shaft run-out and deflection have been the major causes of seal deterioration,

gland leakage and bearing failure in pump operation. DURCOPUMPS have shafts with diameters substantially larger than those traditionally used in centrifugal pumps. Shafts have a maximum run-out of .0015" with center-line deflection of no more than .005" at the impeller under maximum hydraulic load. Bearing housings are a thru-bore design, assuring perfect alignment. With this minimum deflection, packing and mechanical seals last far longer under operating conditions.

Long bearing life

Reduced shaft deflection has made it possible to build Series H pumps for 3500 rpm operation. Heavy duty bearings are selected for a minimum life of two years at this speed under maximum operating stress. The normal life is many times greater than this. Bearings are sealed against oil leakage and external contamination by Durco designed Teflon* lip seals.

Many additional features designed into the Series H Durcopump give maximum flexibility in service. The casing is end suction, top center discharge and self venting with integral feet. Since it uses a rear cover closure, the pumping unit can be removed without disturbing the casing or disconnecting the process piping. *No drilled holes enter the casing at any point.*

Impellers are threaded into the pump shaft, eliminating the impeller nut, and thereby greatly reducing the required NPSH. Head and/or capacity for any pump may be changed merely by changing the impeller diameter. A horizontal seal ring permits adjustment of the impeller without increasing stuffing box pressures.

By the use of an adapter between

the casing and bearing housing, eight pump sizes can be mounted on one bearing housing, utilizing one shaft. As a result, just four bearing housings will handle the complete range of Durcopumps. Since each is engineered for the maximum pump size in its range, most Durcopumps will have a built-in safety margin far beyond normal service requirements.

Simplified Maintenance

Simplified, low-cost maintenance results from maximum parts interchangeability and minimum down-time.

Bearing housings, shafts, and frame adapters on all Durcopumps are interchangeable over a wide range of pump sizes. A complete range of pumps can be maintained in your plant with a surprisingly small spare parts inventory.

The foot mounted reverse casing design was first applied to chemical pumps by Durco. This design holds process down-time and maintenance costs to a minimum. Pumps are designed for single trade maintenance. A millwright or mechanic can remove all rotating parts of a Durcopump from the casing in a matter of minutes. Neither the piping nor the motor need be disturbed. This means that rebuilt or new assemblies can be installed with little or no realignment.

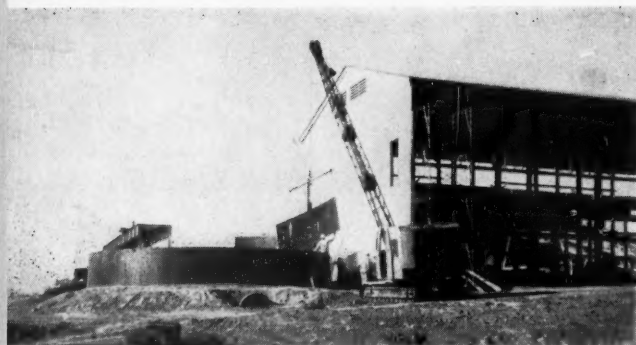
Durcopumps are available in sizes from 1" x 1" to 10" x 8" with capacities from ½ GPM to 4250 GPM, and heads to 345 feet. Durco also manufactures self-priming and submerged pumps for most corrosive services.

You will find that your local Durco Engineer is a reliable source of information on pumping problems and equipment.

*DuPont registered trademark

THE DURIRON COMPANY INC., Dayton, Ohio / Serves the process industries





Today this barite processing plant has gone on stream. It was built in Dierks, Ark., for U. S. Diversified Industries Corp., and is being leased in its entirety from Nationwide Leasing Co., under a six-year plan.

These figures do not include equipment leased from IBM. The production and office equipment leased by the CPI can be classified by industry, as follows:

	Millions
Industrial chemicals	\$28.9
Drugs	\$15.4
Paint	\$ 6.7
Paper	\$19.3
Rubber	\$ 9.2
Ceramics & glass.....	\$ 8.5
Petroleum	\$38.7
Plastics	\$ 5.2

Who Leases What to the CPI

This section will discuss some firms that are active in the leasing of production equipment to the CPI; of course, these companies do not necessarily form a complete or approved list.

Many manufacturers have taken their cue from both fork truck and data-processing concerns, and now give customers the choice of leasing or buying equipment. In many cases, the leasing is done through a company subsidiary. For instance, Trinock, Inc., a recently formed subsidiary of the Emil Greiner Co. in New York, offers leases on Greiner's line of laboratory equipment and instruments. General Electric also has a leasing subsidiary.

A variation of this type of arrangement is where the manufacturer has contracted with a particular leasing company to act as leasing agent. For instance, Boiler Engineering and Supply Company, Phoenixville, Pa., offers its line of Continental package boilers for lease through Nationwide Leasing.

Several other leasing companies have similar arrangements with various manufacturers. Of course, this is only one activity of leasing companies—much of their business consists of leasing out equipment purchased from suppliers chosen by their customers.

Leasing companies have been growing very rapidly. In the equipment field (as distinguished from auto

or truck leasing) the two biggest companies in terms of annual volume are U.S. Leasing Corp., in San Francisco, and Nationwide Leasing in Chicago. Boothe Leasing Corp., San Francisco, and National Equipment Rental, New York, probably come next.

All of these are active in the CPI. Nationwide's long-term leasing plan is doing well; the company has been growing considerably faster than the 40% industry average. In addition to equipment mentioned elsewhere, Nationwide has out on lease such items as gas-fired dryers, Banbury mixers for plastics, and vacuum pumps.

Boothe Leasing was recently able to obtain a 6%, \$10 million loan, which should enable it to continue its good growth. Boothe is considering leasing complete small refineries and chemical plants both here and abroad, and states that several large companies have shown interest in leasing, rather than buying, such plants in Europe.

National Equipment Rental has made up leases for filling and packaging equipment, stainless steel drums and containers, extrusion and blow-molding equipment, power conveyors, stainless steel piping, and complete sprinkler systems. It does a big business in molds for the plastic fabricating industry.

Process Leasing, Inc., New York, is one company specializing in leasing to the chemical and petroleum industries. In addition to individual process equipment, it stands ready to erect, lease and maintain entire small plants for customers.

Equilease Corp., N. Y., (a subsidiary of Electric Auto-Lite) is active in oil and gas production machinery and petrochemical equipment. One of its leases covers a \$2-million off-shore drilling rig for use off Trinidad. The lessees are Texaco, Shell and British Petroleum.

Ionelco, Inc., Houston, is a new company that also specializes in leasing to the petrochemical and petroleum industries. It feels that long-term leasing is just now coming to the fore as a widespread across-the-board development in petroleum.

Langner Leasing Corp., Long Island City, N. Y., was set up a few months ago to specialize in leasing equipment in the \$10,000-\$100,000 range. Initial commitments include color photography processing machinery and electronic equipment.

In the past few years, companies whose main activities lie in other financing fields—notably Beneficial Finance Co., Commercial Credit Co., Standard Finance Corp., C.I.T. Corp., and James Talclott, Inc.—have established leasing subsidiaries. They can thus offer their customers a wide choice of financing.

Since 51 local and regional leasing firms have sprung up in the last two years, the field is getting pretty crowded. It would be naive to assume that all of these companies will become giants—the handful of larger companies are at quite an advantage when it comes to obtaining low-cost funds for expansion. However, this rush to get into the leasing field does give some indication of the promise many companies see in it. And it may also mean that competition between leasing

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companies will keep rates at a fairly reasonable level.

Of course, not all types of companies mentioned in this section are equally aggressive about promoting equipment leasing. As is to be expected, the most active and enthusiastic leasing advocates are the companies that specialize in it, and do nothing else.

Some of the finance companies that have leasing subsidiaries are more restrained. While Commercial Credit calls the recent growth of its leasing business "phenomenal," C.I.T. Corp. has somewhat more of a wait-and-see attitude; it feels that many customers will continue to find other forms of equipment financing at least equally appealing.

As for equipment manufacturers, their opinions also vary. Some are enthusiastic and, as discussed previously, have set up special plans for the lease of their equipment. Others use leasing more as a sales tool, hoping that the customer will eventually buy the equipment and thereby turn the lease into a sale.

Some manufacturers, though prepared to lease out equipment, haven't set up a formal leasing plan because they feel that so far there has not been sufficient interest. Worthington Corp., for instance, states that while it has written out a small number of leases in the last few years, the demand for these on pumps and compressors is very small compared with that for other forms of financing.

Looking at the chemical equipment field as a whole, nobody expects leasing to overshadow purchasing, at least just yet. But it may become considerably more popular, and are now ready to look at some of the reasons for this.

Shortage of Working Capital

Working capital is none too plentiful in the CPI. The rapid expansion in production, research and distribution facilities that has taken place in the last 15 years has not been entirely financed from earnings. As a result, only relatively few companies find themselves either long on idle cash, or able to finance a large new expansion program entirely from internally generated funds. Hence, one or more of the following alternatives usually has to be considered, unless the equipment is leased.

Long-Term Debt Financing—This relatively cheap method is usually available only to the larger companies, and even then may not be sufficient to cover the entire cost of the program. The chances are that such financing will continue to be in tight supply.

Equity Financing—Selling more stock or taking in more partners dilutes ownership and is, therefore, not too popular except in very large programs.

Capital Build Up—Waiting till capital builds up means that the equipment may cost more, or a competitor may have jumped the gun. For instance, a small bleach manufacturer was able to increase his sales 35% recently by leasing plastic filling equipment at a time when his competitors were still packaging bleach in glass. Had he waited until he had enough capital to buy the equipment, he would have

lost this initial advantage. As for replacement programs, waiting obviously postpones the savings from the more efficient equipment.

Unsecured Loans—Bank loans usually have to bear a strict relationship to a company's net worth. It is a characteristic of many expanding companies that net worth has increased much more slowly than sales and production. Furthermore, banks prefer to keep loans on a short-term basis for many customers. All this puts unsecured bank credit at something of a premium, so that it often has to be used exclusively for seasonal and short-term needs, rather than for equipment financing.

Secured Loans—Neither equipment loans or conditional sales contracts involve 100% financing—the down payment is usually about 25%. The effective interest rate may be quite high, except for some conditional sales contracts that are subsidized by the manufacturer. Compared with leasing, the relative attractiveness of these plans may depend somewhat on individual circumstances. Leasing, although involving larger dollar outlays, may be the better choice in many cases. This is discussed in some detail in the booklet "The Pros and Cons of Leasing," available from The Foundation for Management Research, 121 West Adams St., Chicago.

A growing company that is none too long on working capital may favor leasing because it improves the appearance of the balance sheet. This is particularly important to companies that, through long-term loans or various credit agreements, are required to maintain certain net working capital positions. Fixed assets can't be purchased without either reducing the cash balance or increasing the liabilities. If the same fixed assets are leased, the balance sheet remains relatively unaffected, and at most will carry a footnote to the effect that the company is obligated under lease contracts for X dollars of fixed charges a year.

Perhaps it's not completely logical, but a company that leases some of its equipment and is thereby able to show a good current asset position will usually have an easier time getting funds for expansion than one that has most of its capital tied up in equipment.

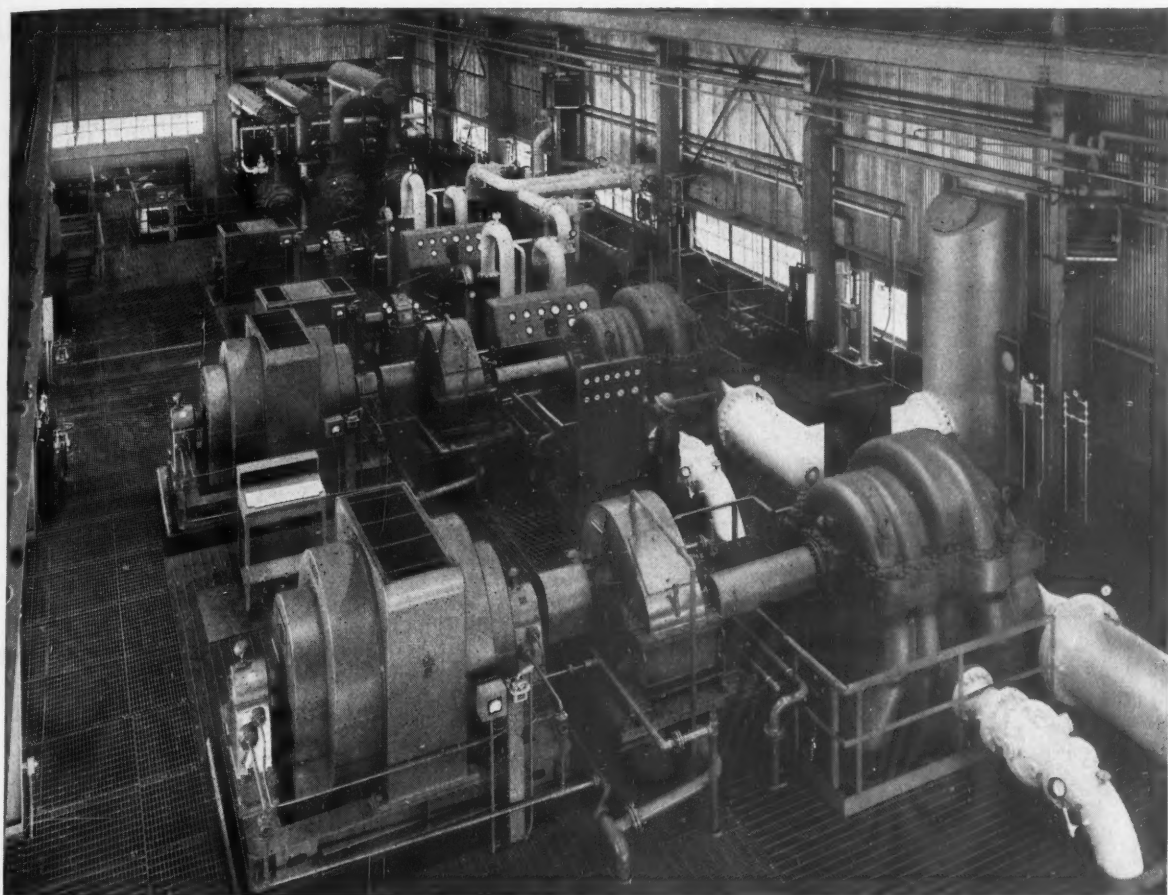
Obsolescence and Replacement

Most CPI equipment leased so far has been for expansion purposes, not for replacement. Much of it will eventually be replaced by more leased equipment, according to several lessees who have been queried on this point. Says Paul A. Duane, president of Holiday Chemical Co., Newburn, Pa., "I have a modern, model plant through leasing. The monthly leasing costs are small and can easily be met. The fees are about equal to those on borrowing. I would never buy another piece of equipment outright, nor would I finance it." Holiday Chemical leases all the equipment for an autobatch liquid fertilizer plant from Nationwide.

While there were variations in degree of enthusiasm, a sampling of some companies that are presently leasing equipment from major concerns in the field

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One good reason why so much U.S. oxygen capacity for steelmaking is handled by Clark compressors, is the ability of Clark engineers to develop complete compressor systems.

A typical steel mill oxygen plant installation is pictured above. In addition to being equipped with four proven Clark centrifugal oxygen compressors and a non-lube reciprocating unit handling nitrogen, this plant uses the new Clark IsoTemp centrifugal air compressor. Two of these machines are shown handling "100 lb. air" in the first stage of air separation.

Twenty-five IsoTemp compressors have been purchased for installation throughout the world after a careful analysis of features by informed U. S. and European engineers. Among the factors which influenced their choice: Four-stage, isothermal type design; the use of integral base-mounted intercoolers between each compression stage for maximum efficiency; low installation cost as a result of compact design; isolated bearing chambers combined with a unique seal porting system to eliminate lube oil contamination of the compressed air stream.

The user's confidence in the reliability of the new Clark IsoTemp is well founded. These machines have met all predicted performance guarantees and have proved trouble-free in every respect.

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indicated that most lessees seemed happy with their arrangement, and were inclined to do more leasing when the time came.

Simultaneously, more CPI companies are turning to leasing for certain types of obsolescence-prone equipment. They feel that with leasing, there is less temptation to keep the equipment once it is outdated, that depreciation is put on a more realistic schedule and that the newest equipment can be obtained once it has become available. Much packaging, filling and plastic molding machinery is leased for this reason.

Intricacy and Cost of New Equipment

Equipment is becoming more intricate and expensive, which often makes leasing attractive, at least as a supplemental step.

The leasing of data-processing equipment is, of course, an old story—of more recent vintage are leasing plans for other types of electronic instrumentation.

For instance, Technical Leasing Co., San Diego, Calif. was organized this year to specialize in this field. It offers CPI companies leases on mass spectrometers, leak detectors, chromatographs, refractometers, oscillographs and various data-processing equipment.

Another example was mentioned in *CE* recently—Dresser Electronics in Houston is making mobile data-logging equipment available on a lease or rental basis. This means that process information that can only be gathered by logging equipment can be obtained without investing the \$50-125,000 that a mobile unit would cost.

Tax Considerations

If one avoids certain pitfalls, a well-planned CPI equipment lease can put depreciation on a more realistic basis; however, it is largely a question of tax postponement rather than outright tax savings. Nevertheless, the postponement can come in very handy, especially when startup expenses, market development and other expansion costs have to be met.

As for depreciation, the CPI is still laboring under the archaic Schedule F, which ascribes a useful life of from 15 to 30 years for much chemical equipment. A distillation tower for instance, is ascribed a 15-year life. If its life, considering hard wear and obsolescence, is actually closer to six years, then obtaining it on a five-year lease with a one-year renewal obtains fairer tax treatment than would ownership.

Since the lease represents a pretax expense, all costs would be written off after five years. Under ownership, no more than 52% could be written off during the first five years. If the straight-line method were used, instead of the more helpful Double-Declining Balance or Sum-of-the-Digits, only 30% would be written off by that time.

In order to obtain this tax treatment, the lease should avoid the following:

- A term so short that the payments materially exceed fair rental value.

- A purchase or renewal option that bears no relation to fair value. (Most large leases do not contain purchase options. If an option is necessary, it is negotiated when the lease expires, the reputation of the lessor acting as substitute for details spelled out in advance.)

- A clause that breaks down the lease payments into interest or equity accumulation.

From the above, it can be seen that to avoid tax controversies the best lease is not one with only nominal renewal or purchase option costs, but one where such costs at least approximate realistic values, with a corresponding decrease in costs during the initial term of the lease.

More Plans Available

Both manufacturers and leasing companies now have a large number of plans, and in many cases they will tailor-make one to suit the lessee's special requirements. Recently announced were three widely contrasting items:

1. A plan for renting heavy water was disclosed by Bio-Rad Laboratories, Richmond, Calif. The D₂O can be obtained for periods of three months to two years. The charge is based on the length of time the water has been kept and the amount of dilution it has undergone. Returned water is checked for tritium contamination and is then returned to the process stream for re-enrichment to 99.8%. Plans are being considered for similar programs covering other stable isotopes, including nitrogen-15 and carbon-13. (This sort of arrangement is considered a rental rather than a lease; we included it as a matter of interest.)

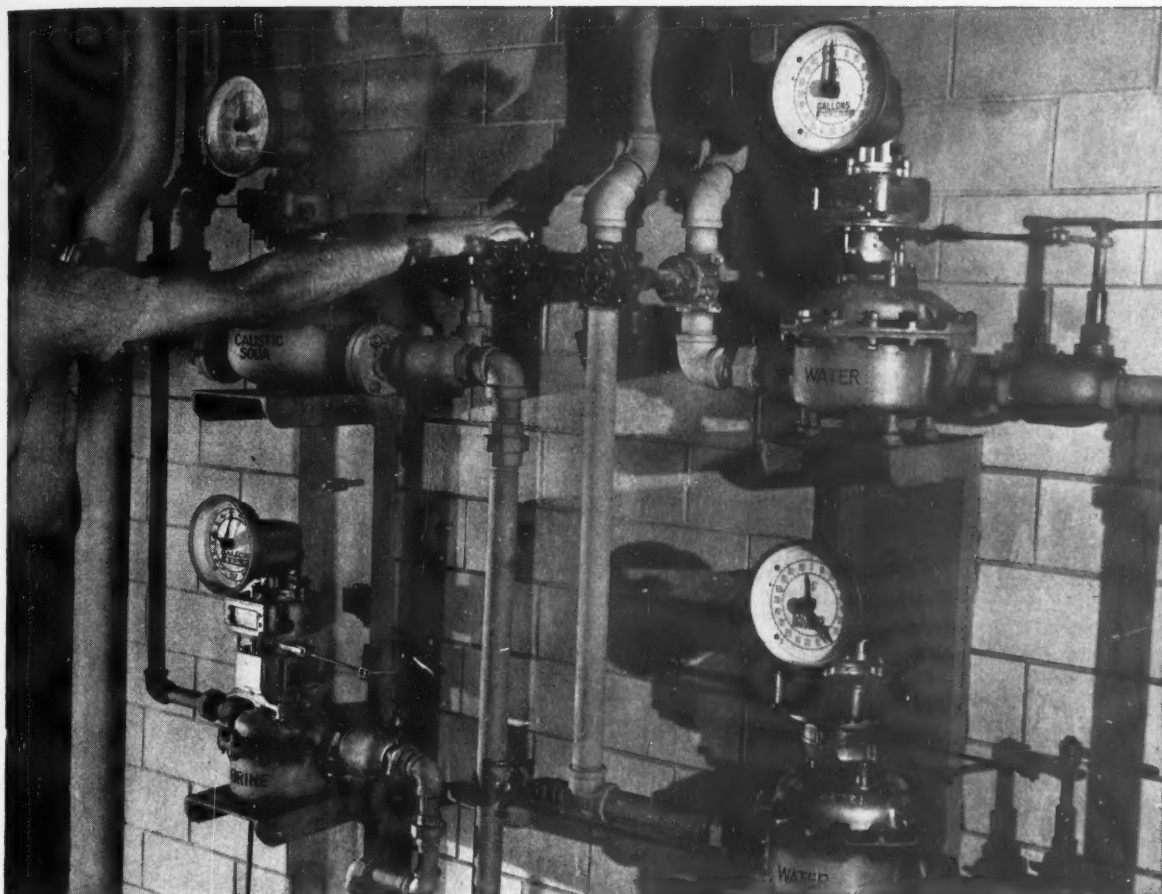
2. An extra-long-term lease plan primarily for chemical companies was announced last winter by Nationwide Leasing. To keep costs low, it was limited to companies with a net worth of at least \$1 million and with a five-year record of profitable operations. These companies could obtain leases for equipment costing \$25,000 or more for six to twelve-year terms. Most other equipment leases run from three to five years.

3. Perkin-Elmer Corp. came up with a specific leasing program of its own last year whereby its spectrophotometers and gas chromatography instruments could be leased for three-year terms (with renewal options) through Horton Equipment Leasing. A one-year free service warranty is included in the plan.

Growth of Sale Leasebacks

Many CPI companies that have expanded very rapidly—faster than their working capital—may find themselves equipment rich but dollar poor. In such cases, the company may want to sell part of its old equipment to a leasing company, then immediately lease it back for a stated number of years. Thus, the lessor retains use of its equipment but generates working capital for other phases of operations.

Nationwide Leasing, which has just signed a \$14-million lease-back deal with a large eastern baking



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concern, predicts an increasing number of these arrangements. Its president feels that since this new plan permits companies to sell fully or partially depreciated equipment at greater than book value, the plan will be financially attractive even to larger firms.

Other Reasons That Apply to the CPI

If a big corporation finds that a surprise development requires expenditures for which no allowance has been made in the budget, leasing is often considered as an alternative to getting approval to exceed the budget.

The president of Boothe Leasing cited a good example that involves red-tape cutting, as well as some other factors. A major oil company estimated that if it acquired two package boiler units at a total cost of \$500,000, it could save \$100,000 a year before taxes. However, this company like many others required capital equipment to pay for itself in four years, which means that a pretax saving of \$250,000 would have been necessary to obtain routine approval for their purchase. Instead of trying to get a special ruling, which probably would have been negative, the company found it could justify the boilers by obtaining them on a ten-year lease, with an annual cost of \$70,000. This saved \$30,000 a year without tying up any capital.

Emphasis Shift—Leasing companies borrow funds to acquire equipment to be leased. Institutions that supply some of these funds sometimes insist that the equipment purchased with these funds be readily repossessable in the event of default. Much chemical equipment is closely integrated with plant real estate and hence does not fall into this category. For this reason, many leasing companies at first were slow to train their guns on the CPI.

However, this trend is changing. Most leasing companies, and the institutions that supply them with funds, now place more emphasis on the credit rating of the lessee than on the nature of the equipment. This means that almost any type of chemical equipment—including custom designs and installations—can be leased from some company or other, if the lessee represents a reasonable credit risk.

Service Leases—Under a service lease, the lessor does the servicing. This form of leasing has been gaining in popularity, particularly where items such as electronic equipment and fork trucks are concerned. Monsanto, for instance, gives its plant managers the choice of either purchasing fork trucks or operating them under service leases.

Government Work—Equipment is often not fully depreciated when work on a government contract is finished. This can be expensive unless the equipment can be put to other use. Hence, leasing is often favored (the government considers equipment leasing a legitimate expense on cost-plus contracts).

Nationwide Leasing has come up with a special plan for CPI companies doing research and development work for the government. Applying to both standard and custom-built equipment, the plan features a cancellation clause, and enables the lessees to

tailor payments and the length of the lease to their contracts.

Will There Be a Leasing Stampede?

Now that we have discussed the main reasons the CPI can be expected to step up equipment leasing, let us explain why we don't think it will be a real stampede. There are a number of tempering factors.

Many companies can pay for new expansion and replacement programs by using some combination of internally generated funds and long-term loans. They can thus avoid the higher financing costs inherent in leasing.

There is a possibility that Congress may liberalize depreciation schedules, or that some tax incentive may be given to capital expansion. This may reduce the tax-postponement advantages of leasing. Some companies feel cautious about these advantages anyway, because the Internal Revenue Service has issued few hard and fast rules. (Most leasing companies no longer stress these advantages as much as they used to.) As for the tax incentive that was proposed this year, its effect on the relative attractiveness of leasing is unclear. If leasing companies themselves qualify for the exemption, it might stimulate leasing as well as purchasing.

Some companies are annoyed by the fact that unless you use a purchase option, you never really own the equipment and don't benefit from its scrap value. Actually, the scrap or renewal value is taken into account when the cost of the lease is computed; in fact, most leasing companies make little or no profit on the lease until the point of renewal or scrapping is reached.

Some companies like to own all productive assets as a matter of principle, and to prevent the possibility of over-extension. In connection with the latter, it should be pointed out that a company about to over-extend itself would have difficulty getting a standard lease, particularly for chemical equipment.

Some companies find other methods of equipment financing more advantageous. After comparing the best available lease plan with the best other means of financing, some decide in favor of leasing, some in favor of buying, depending on such factors as availability and individual rate of return on working capital, tax objectives, and factors previously discussed.

Hence, we don't expect CPI leasing to really skyrocket in the near future. As we stated earlier, we nevertheless expect it to grow quite a bit, probably for a number of years.

If, somewhere along the line, you decide that leasing affords advantages over other forms of financing, you will probably want to compare leases from different companies. When making this comparison, don't just compare prices—also compare suitability of the lease, advance-deposit requirements, handling of freight and installation charges, possible small-print restrictions, termination clauses, maintenance service factors, and the reputation for financial responsibility of the lessor.

NEW! VAR SOL STAYS SWEET!



"It's here my friends, new improved Varsol... the solvent with long-lasting freshness. Produced by a unique, new Esso hydrofining process, today's Varsol retains its efficient solvency, yet keeps its fresh, sweet smell locked in... even after long storage or many processings in your plant. Like all Esso solvents, new improved Varsol reaches your plant fresh, uniform, and on schedule from modern, conveniently located storage facilities. Don't hesitate to call on your local Esso Representative for further information and expert technical assistance. Or write: 15 West 51st Street, New York 19, New York. (And tell 'em Nosey sent you!)" *Nosey*

HUMBLE OIL & REFINING COMPANY



Factory-applied stainless steel jacket protects pipeline insulation from fire and corrosive chemicals, and is competitive with other insulation coverings.

Stainless Steel Protects Pipeline Insulation

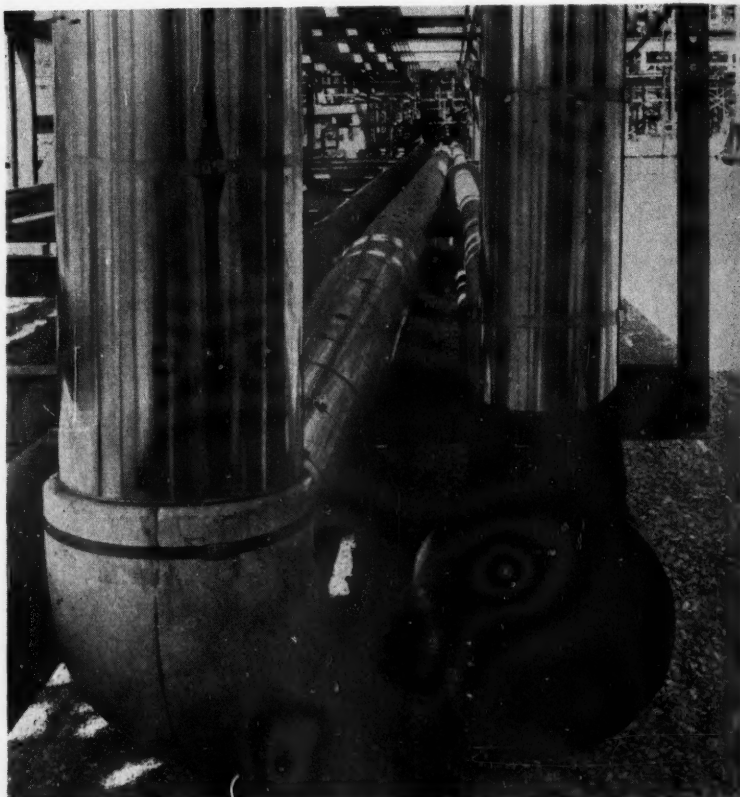
A new stainless steel covering for pipeline insulation provides increased fire protection, as well as better corrosion resistance, greater strength and lower surface temperatures.

Union Carbide Chemicals Co. has installed about 16,000 feet of this stainless-jacketed insulation at its chemical processing plants in West Virginia. Jones & Laughlin Steel Corp. is using it on 5,000 feet of 18-in. steam line running through its Pittsburgh Works and across the Monongahela River.

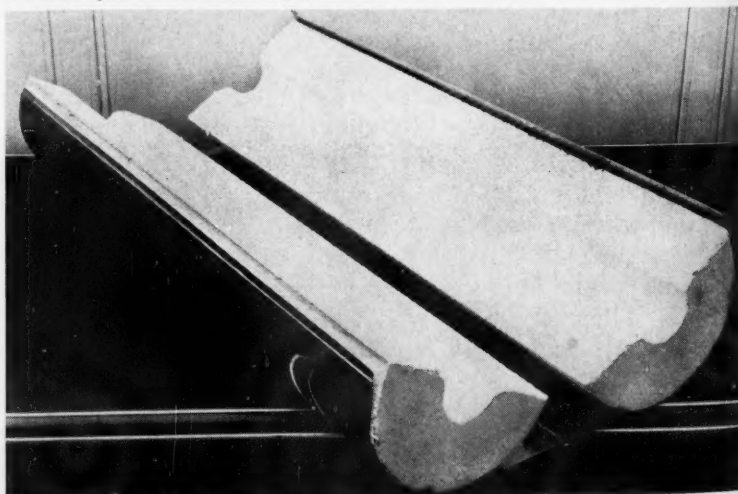
Calcium silicate pipeline insulation with an integral stainless steel covering is being produced by Johns-Manville under the trade name of Metal-On.

Advantages claimed for the stainless covering are:

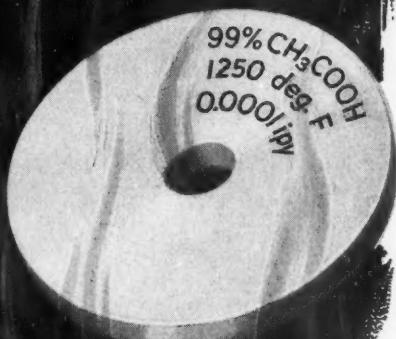
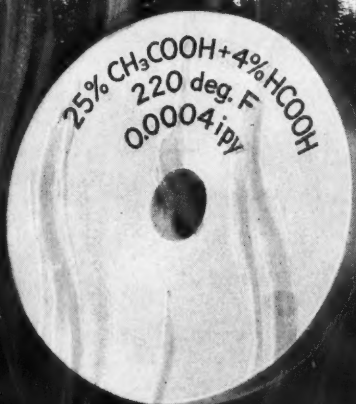
- Fire resistance. Stainless steel stands up for 1½ hr. to a gasoline fire that will melt aluminum pipe covering in 1-3 min. (The molten aluminum may start subsidiary fires or injure personnel. And after it has melted off, the unprotected insulation is easily dam-



Stainless jackets on outdoor pipelines at Union Carbide Chemicals Co. plant.



Close-up look at calcium silicate pipe insulation with integral jacket.



Organic Acids Causing Corrosion?

...Test **HAYNES** Alloys

HASTELLOY alloy C and nine other corrosion-resistant alloys were tested in hot acetic acid vapors containing traces of oxidizing contaminants. HASTELLOY alloy C had a penetration rate of only 0.0007 inches per year—lowest among all nine competitive alloys. Others varied from 0.005 to 0.5 inches per year and were severely pitted. This test showed one manufacturer of organic chemicals how he could keep his maintenance costs to a minimum before a process was even on stream.

How much money can you save in your plant? Why not find out for sure by testing HAYNES alloys.

We'll gladly send you samples. There are 6 HAYNES corrosion-resistant alloys. To help us select the one most likely to solve your problem, we suggest that you send us a letter outlining the corrosive conditions in your plant. To learn more about HASTELLOY alloys, ask for a copy of our book, "Corrosion Resistance of HAYNES Alloys."

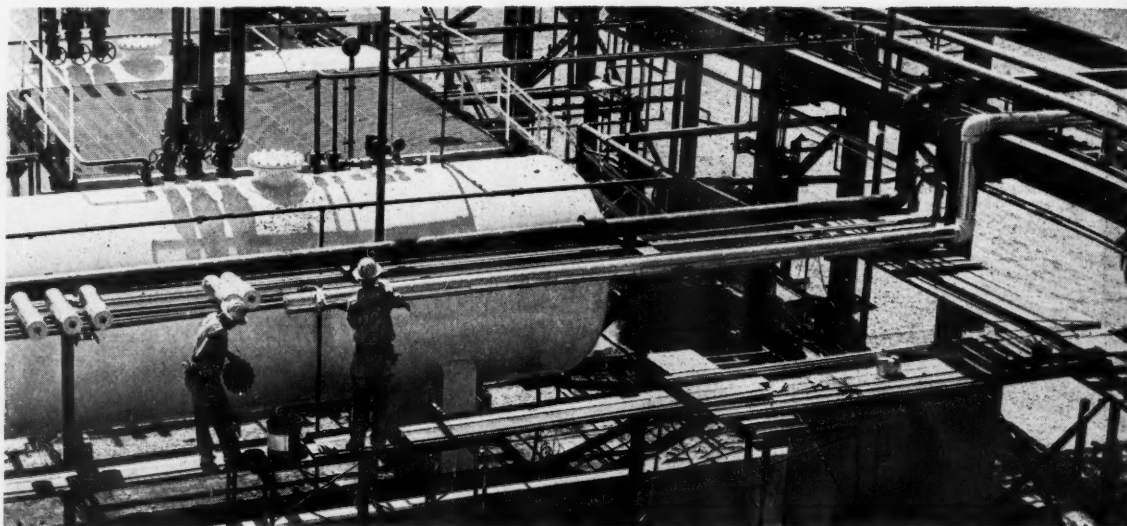
HAYNES ALLOYS

HAYNES STELLITE COMPANY

Division of
Union Carbide Corporation
Kokomo, Indiana

**UNION
CARBIDE**

The terms "Haynes," "Hastelloy," and "Union Carbide" are registered trade-marks of Union Carbide Corporation.



Application of newly developed insulation is quick and does not require use of highly skilled labor.

aged by hose streams used in fighting the fire.) The stainless steel covering, in addition to resisting the fire, is sturdy enough to turn aside high-pressure hose streams, keeping the insulation dry and protected.

- **Chemical resistance.** Stainless steel's resistance to corrosion is well known, whereas aluminum pipe covering stands up to most acids, but is not resistant to alkalis. Also, stainless retains its bright polish for long periods, keeping it attractive without the need for costly maintenance painting.

- **Mechanical strength.** The high strength of the 0.01-in.-thick stainless jacket protects the insulation from mechanical abuse such as is caused by men standing or walking on the lines. In addition, the jacket is strong enough to permit insulated pipes to be laid directly on pipe racks; the support does not have to carry the pipe itself.

- **Low surface temperature.** The high emissivity of stainless helps keep the surface cooler to the touch. A 500 F. line, covered with 2½-in. of 85% magnesia insulation will have a surface temperature of about 150 F. (in 70 F. air). With an aluminum jacket, the surface temperature would be between 190 and 220 F. The aluminum jacket would be hot enough to cause pain-

ful burns, the stainless jacket would not.

► **How Applied** — The insulation and jacket are shipped from the factory in standard 36-in. lengths. The stainless steel jacket is springy enough so that the two halves of the insulation can be opened up and slipped over the pipe. The installer then engages the longitudinal seam and can then join the covered insulation to the piece next to it. A stainless steel band, backed with a nonsetting sealer, covers the gap between the two insulation sections. The band is applied to the joint after a protective paper backing is peeled off. A stainless strap around the band holds it permanently in place.

► **Stainless Sheet**—Stainless sheet, having a thickness of 0.01 in. has been found satisfactory as a jacketing. It has sufficient mechanical strength to take the abuse it is likely to receive and in addition has the lowest cost on a square foot basis. Thicker sheets cost more because of the increased amount of metal they contain. Sheet thinner than 0.01 in. costs more because of increased rolling charges. If the costs of thinner stainless sheet could be brought down, an 0.008-in. thickness probably would suffice.

► **Costs** — The installed cost of stainless steel jacketed insulation is

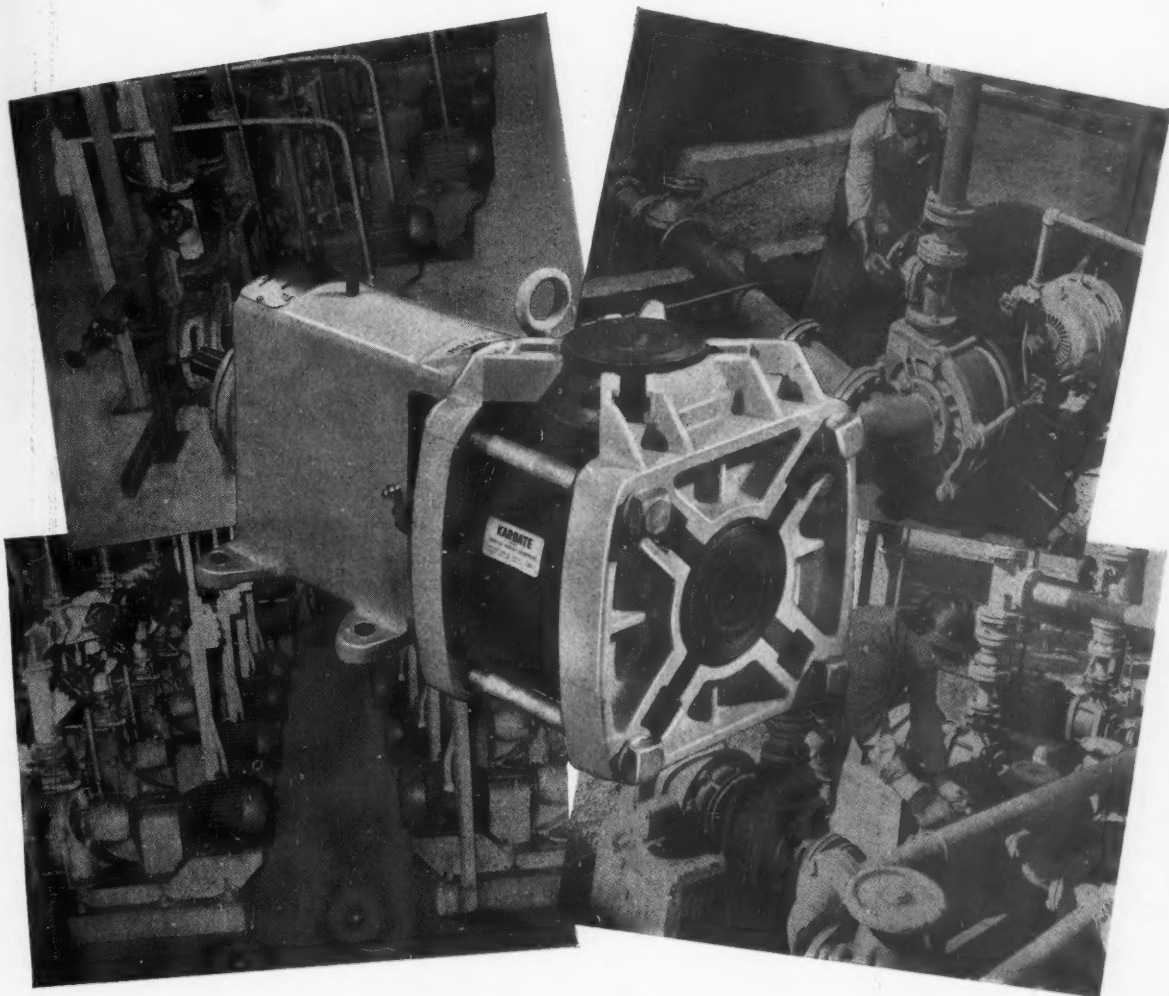
approximately 8% higher than insulation covered with field-applied fire-resistant mastic (a polyvinyl acetate mastic is most widely used). The stainless jacketed insulation is about one-third higher than insulation having a factory applied aluminum jacket.

The stainless sheet used by Johns-Manville is still a special-order item, rolled by Jones and Loughlin Steel Corp. Although J&L previously made an 0.01-in. stainless sheet, it was rolled in an 18-in. width. This was not satisfactory since pipe insulation is manufactured in standard lengths of 36 in., twice the width of the available stainless sheet.

► **Drawbacks** — Aside from its higher initial cost, the new insulation has one major drawback. It is available only for straight pipelines. Fittings (i.e., flanges, elbows, tees, etc.) or valves have to be insulated separately. This is normally done by applying a fire-resistant polyvinyl acetate mastic. The plastic is generally "palmed" on to a thickness of ½-in. in the final (dry) state. These plastic-covered sections may be painted in a silver color to match the rest of the pipeline.

Work is being done on the development of stainless-jacketed shaped insulation for fittings, but these are not yet commercially available.

NEW FRAME-MOUNTED MODELS EXPAND "KARBATE" PUMP LINE!



National Carbon's addition of "Karbate" frame-mounted Type F pumps to its line provides today's widest selection of impervious graphite centrifugal pumps!

Designed and built by the world's leading producer of non-metallic centrifugal pumps, the new Type F has 1, 1½, and 2-inch discharge openings, and features the same wet end parts and mechanical seal used on proved motor-mounted models.

With capacities to 140 gpm and heads to 67 feet, the new frame-mounted Type F brings to 32 the num-

ber of standard sizes of "Karbate" impervious graphite pumps . . . offering discharge openings ranging from 1 to 4 inches, capacities from 5 to 1500 gpm, and heads from 15 to 120 feet.

You can depend on the unsurpassed corrosion resistance of "Karbate" impervious graphite centrifugal pumps for all corrosive pumping service. For details on models and sizes, write: National Carbon Company, Division of Union Carbide Corporation, 270 Park Avenue, New York 17, N. Y. *In Canada:* Union Carbide Canada Limited, Toronto.

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for products of

NATIONAL CARBON COMPANY

**UNION
CARBIDE**

NUCERITE MOVES TO THE PRODUCTION LINE

Ceramic-metal composite passes field-test trials for high-temperature corrosion resistance and is now available in limited production.

Nucerite, (Pfaudler's trademarked name for ceramic-coated metals) is now available on a limited production basis. Introduced last September (see *Chem. Eng.*, Oct. 3, 1960, p. 130) on a "laboratory development status," field evaluation tests have shown that Nucerite will withstand high-temperature corrosive environments that would destroy most metals after only a brief exposure.

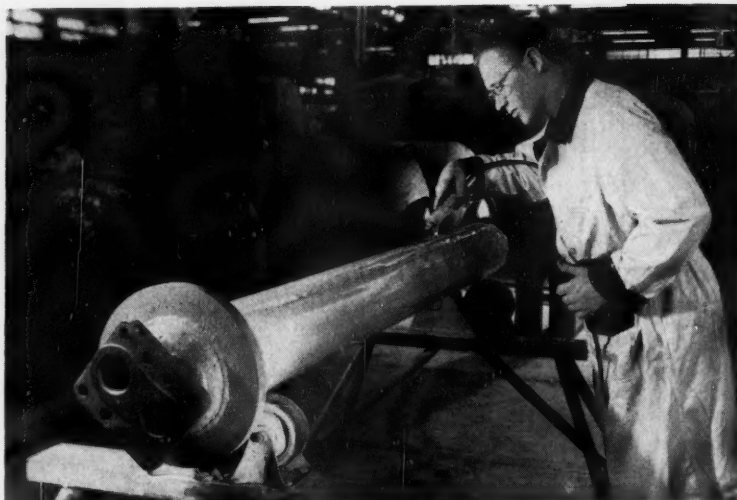
Nucerite is the name given to a whole family of ceramic-metal composites. These consist of a ceramic structure (characterized by a large number of very small crystals) physically and chemically bonded to a structural substrate metal. Compared with corrosion-resistant ceramic materials that might be used in similar applications, Nucerite has better mechanical strength, thermal shock resistance, heat conduction and high-temperature stability. Better abrasion and erosion resistance are also claimed.

► **In Limited Production**—According to Pfaudler, the change to "limited production" status means that orders will be accepted for production equipment if field test or lab data show its suitability for a particular application.

Samples for testing are available from Pfaudler, at a nominal cost.

The ceramic component of Nucerite can be applied to equipment that has a simple shape, uniform cross-section and no sharp corners.

A number of different formulations of ceramic are used in making Nucerite; these are chosen on the basis of the metal to be coated and



Inspector with high-voltage tester checks integrity of ceramic coating.

the proposed use of the finished product.

As a general rule, carbon steel can be used as the substrate metal at temperatures from 450 to 700 F. From 750 to 1,500 F., stainless steels, Inconel or one of the refractory metals is required, owing to the low strength of carbon steel at elevated temperatures.

► **Progress Report**—Pfaudler has issued a progress report based on the field-testing of over a hundred samples. High-temperature corrosion resistance (between 500 and 1,500 F.) holds the greatest promise for CPI use—even though impact, erosion and abrasion resistance will continue to be of major importance in specific applications. The field tests have pointed up the fact that Nucerite will withstand environments that will destroy most metals after only brief exposure.

► **Test Results**—Although many of the tests cannot be reported owing to secrecy agreements, the following examples show some of the environments that Nucerite has successfully resisted:

- Metal halides at 1,202 and

- 1,292 F. (Inconel fails in this service in 2-3 weeks.)

- Chlorine and carbon tetrachloride mixtures at 600 F. Quarter-inch stainless steel plate would be corroded through in a matter of minutes.)

- Refractory metal chlorides at 485 F.

- Coal tar pitch at 750 F. (Thermal shock caused the failure of the solid ceramic materials previously used in this application.)

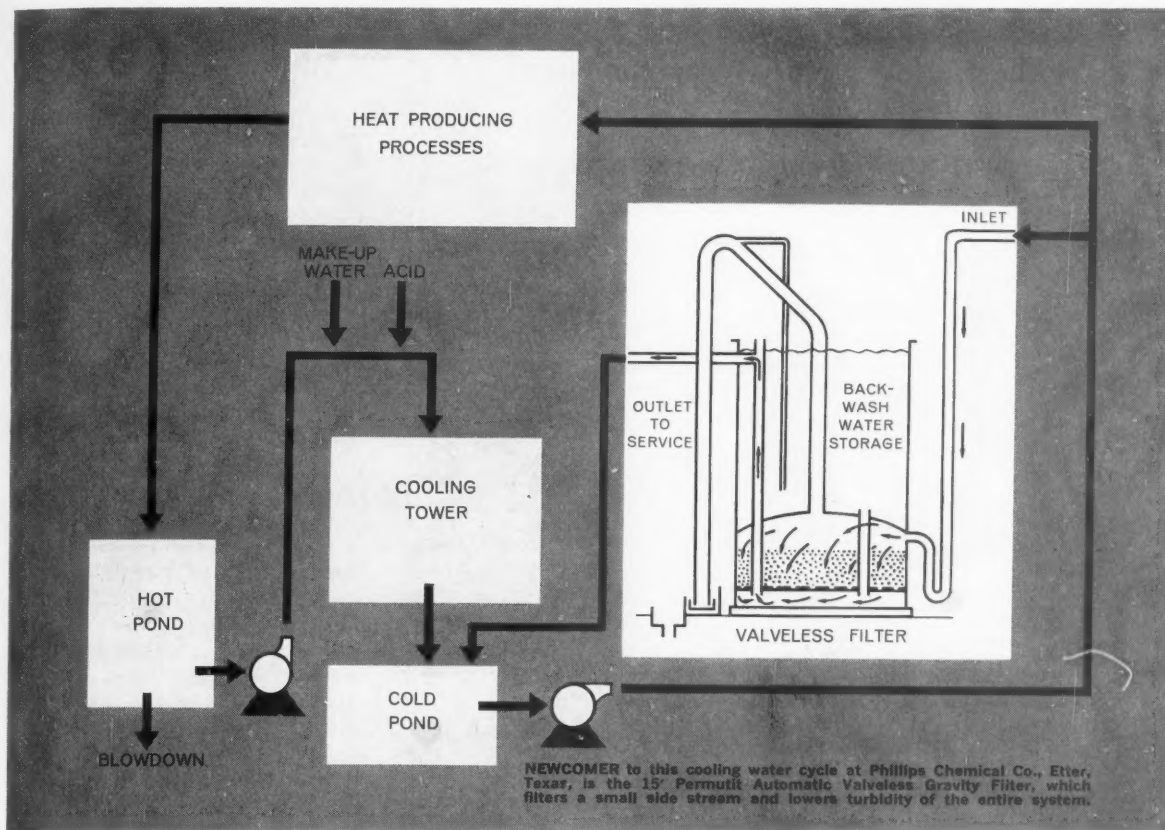
- Aqua regia plus heavy abrasive at 225 F. (Tantalum is the only metal that would stand up to this environment.)

- HCl plus solids (moving at 100 ft./sec.) at 1,112 F.

In all of the foregoing examples, the conditions were those actually used in the field tests—they do not indicate environmental limits.

► **Orders in Production**—Pfaudler has already received orders for 6-in. pipe, 2½-in. boiler tube, a 6½-in. bayonet heater (pictured above), donuts and flanges for electrical barriers in pipelines, 12-in. and 18-in.-dia. columns, finger baffles, and a 300-gal. closed-top reactor.

FLUIDICS* AT WORK



New way to shrink yearly maintenance costs—improve heat exchanger operation

Here is a new wrinkle in cooling-tower operation:

Side stream filtration. It can appreciably cut your yearly bill for cleaning fouled heat exchanger surfaces and condenser tubes.

Between the cooling-tower and the heat-exchange operation stands a newcomer to the system—a Permutit® Automatic Valveless Gravity Filter.

Its job is to clean up a small portion of the main cooling water stream, roughly 1% to 5%. By continuously filtering this small side stream the turbidity of all the cooling water is reduced and held to an acceptably low level.

In the system shown here, suspended matter dropped from 2.0 ppm to 0.5 ppm in just one week, and continued to decrease thereafter.

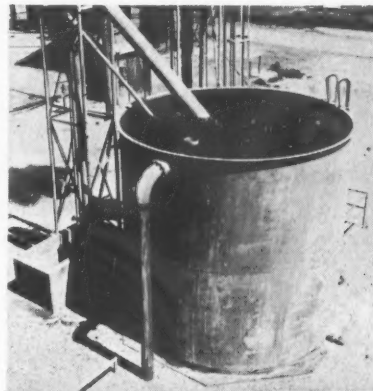
Less turbidity in the cooling water

means less fouling of heat exchange equipment. Less fouling, fewer cleanings, more efficient operation.

Costs nothing to operate: To sweeten your savings a little more, the Permutit Valveless Gravity Filter is automatic, in every sense of the word. It operates itself, backwashes itself. Has no moving parts, requires no attendant, no power, no extra pumps. The water used to wash serves as part of the system blow-off—at no extra cost.

Now in use: Proved in this new application, the Permutit Automatic Valveless Gravity Filter is already saving money for several companies.

All you need, to join them, is a little space near your cooling tower, and a Permutit Automatic Valveless Gravity Filter. For more facts, write: Permutit Division, 50 West 44th Street, New York 36, New York.



FILTER in use at Phillips Chemical Co. is entirely automatic. Shuts itself off when backwashing, puts itself back into operation when backwashing is completed.



PFAUDLER PERMUTIT INC.

A world-wide company with plants in Germany, Great Britain, Canada, Mexico, Japan, as well as the U.S.A.

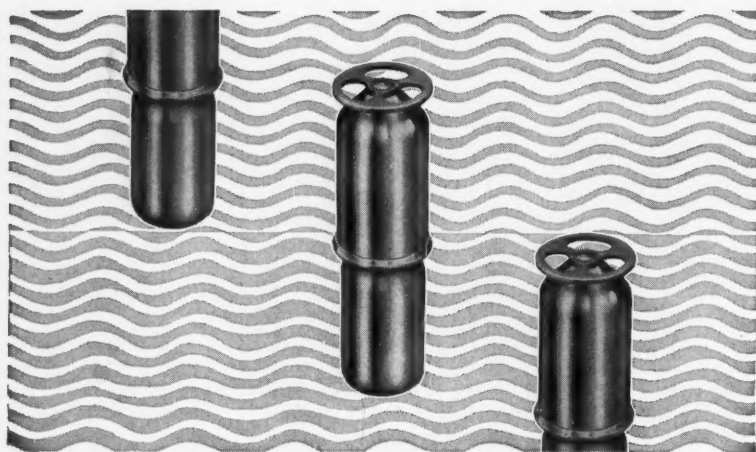
*FLUIDICS is the Pfaudler Permutit program that integrates knowledge, equipment and experience in solving problems involving fluids.

Now you can mix or match ROTAMETER

capacities, pressure drops, prices

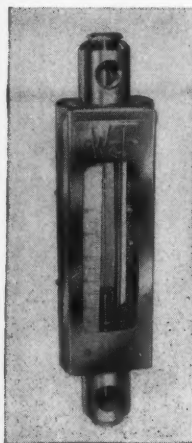
with the new

W&T VAREA-METER



Now you can have a useable kind of adaptability with Wallace & Tiernan's complete new line of Varea-meters. Deeply overlapping capacities and integrated tube-float combinations let you pinpoint capacity exactly. You get a truly job-proportioned rotameter.

Eight floats per tube size give a wide capacity selection. And Varea-meter capacities overlap 50% from meter size to meter size. For any given capacity you get a choice of two sizes. The larger gives you less pressure drop; the smaller costs less.



Size for size, Varea-meters give you more capacity than any other rotameter. A new float design and increased tube taper allow more throughput. You specify a smaller Varea-meter, which costs less.

New W&T Varea-meters come in $\frac{3}{8}$ " through 3" sizes with 5" and 10" scales. They measure up to 310 gpm water or 1300 scfm air over a range of at least 10 to 1. Transmitters, magnetic indicators, and the usual accessories are available. Varea-meters conform to ISA Recommended Practice.

For more information, write Dept. V-5.29.



WALLACE & TIERNAN INC.
25 MAIN STREET, BELLEVILLE 9, NEW JERSEY

CPI NEWS BRIEFS . . .

Continued from page 78

tion, both Aclar fluorohalocarbon and Capran polyamide films are specialty products for the packaging and electronics industries.

Cerro Corp. has taken an option on 1,030 acres of Columbia River deepwater frontage at Wauna, Ore. Proposed for the site is a \$35-million, 55,000-ton/yr. primary aluminum smelter, power for which would come from the Bonneville Power Administration under the terms of a contract already signed. Total investment in the single-potline works probably comes close to \$50 million.

Morgan City and Port Allen, La., are now connected by a \$30-million canal that bypasses the outmoded Plaquemine, La., lock in the intra-coastal waterway. (Port Allen is located directly across the Mississippi River from Baton Rouge, the booming petrochemical center.) Formerly, tows heading westward along the Gulf from Baton Rouge had to be broken up at Plaquemine while each barge was hauled through individually, an expensive inconvenience that had been causing more and more ships to be routed down the Mississippi to New Orleans—a 160-mi. longer distance—in order to avoid the lock. New channel meets the widened and deepened old waterway at Indian Village, La.

American Cyanamid Co. plans a 40% expansion of anhydrous ammonia capacity, a doubling of storage facilities, and additional loading facilities at Fortier, La. Construction begins shortly, with \$3 million scheduled to be spent before completion late next year.

Celanese Corp. of America has ordered a computer control system for part of its 500-million-lb./yr. acetyls complex now under construction at Bay City, Tex. Minneapolis-Honeywell Regulator Co.'s H290 digital package will monitor and control two processes: an acetaldehyde route from ethylene, licensed to Celanese by Germany's

Aldehyd GmbH., and a 2-ethyl hexanol route. The Bay City plant is due on stream in 1962.

Humble Oil & Refining Co. is expanding its 40-million-lb./yr. polyolefin capacity at Baytown, Tex., by about 50%. Current production includes 20 grades of Escon-brand polypropylene. Expansion is scheduled for completion by November, but the firm already sees further moves to bring capacity up to 80 million lb./yr. by the second half of next year.

St. Francisville Paper Co., a joint subsidiary of Crown Zellerbach Corp. and Time Inc., plans to spend \$25 million to double capacity at its paper mill in St. Francisville, La. New rating will be 160,000 tons/yr. of coated printing papers, about half of which will go to Time Inc. for its various publications.

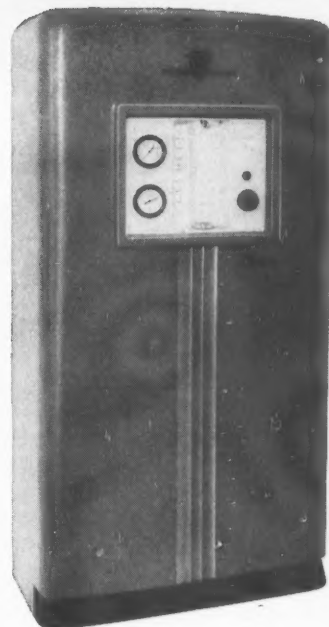
In a separate move, Crown Zellerbach is undertaking an \$8.2-million modernization and diversification program at its Bogalusa, La., pulp and paper mill. Major item will be installation of an all-purpose paper machine to produce a variety of bleached kraft specialty papers.

The Chemstrand Corp., a subsidiary of Monsanto Chemical Co., plans to hike nylon yarn capacity by 200% at Greenwood, S. C. Scheduled for completion by next May, facility complements the firm's Pensacola, Fla., nylon plant, which Chemstrand bills as the largest nylon installation in the world.

Air Products Inc. has dedicated the first of five tonnage oxygen plants to go on stream this year. Located in Granite City, Ill., the \$6-million unit turns out more than 170 tons/day of liquid and gaseous oxygen, principally for Granite City Steel Co. Byproducts of the air-separation unit are nitrogen, argon, hydrogen, helium and acetylene.

Cooperative Farm Chemicals Assn., Lawrence, Kan., has awarded Chemical Construction Corp. a contract to design and

Solve
your
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water
and
waste
problems -



W&T V-notch Chlorinators

Wallace & Tiernan V-notch chlorinators provide the economical answer to water- and waste-treatment problems. Chlorine's bacteria- and slime-killing power keeps process and cooling waters slime-free. It destroys cyanide and phenolic wastes. It helps prevent organic fouling of demineralizers.

This Series A-721 V-notch Chlorinator feeds up to 8000 lb./day, over a 20:1 range. It will treat nearly 100 million gallons of water with 10 ppm dosage . . . destroy 1200 lb. of cyanide waste . . . oxidize 800 lb. of ammonia nitrogen. Other V-notch models feed smaller amounts of chlorine, to 10 lb./day. All models can be used for manual, intermittent start-stop, or fully automatic operation. And the V-notch Variable-Orifice gives you pinpoint control.

- *If you have a water or waste treatment problem, W&T has the equipment and know-how to solve it. Write Dept. S-148.29.*



In Formaldehyde Service Like This...

CHEMLON®

RINGS

**give more than
twice the life of
other packings**

This report was made by the Spencer Chemical Co.'s Chicago Works on their Type 316 stainless steel valves handling 45% formaldehyde solutions with a pH as low as 3.5. Previous to the installation of Chemlon Molded Rings, packing life had been limited to six months. The Chemlon Rings have been in service over 1 year and continue to stand up well.

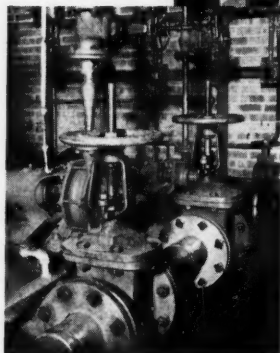
**HERE AGAIN IS PROOF THAT
CHEMLON PACKINGS ARE
THE POSITIVE ANSWER TO
YOUR TOUGH-TO-HANDLE
CORROSIVE AND TOXIC LIQUID
PROBLEMS AT TEMPERATURES
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AND WITHOUT FEAR OF
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Chemlon Packings are fabricated from DuPont Teflon. Machined and molded types are supplied in ring form and are available with square or beveled ends or in odd shapes for special fittings.

Tell us about your problems or requirements. Request Bulletin P-325.

Crane Packing Company, 6451 Oakton Street,
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Photograph
courtesy of
Spencer
Chemical Co.

The ability of these stainless steel valves and Chemlon Rings to withstand the formalin solution contributes to the extremely low 0.2 ppm. avg. iron content of Spencer's formaldehyde.



CRANE PACKING COMPANY

CPI NEWS BRIEFS . . .

erect a 120-ton/day nitric acid plant at Lawrence. Last year, Chemico placed on stream at the site a similar plant in the record-setting time of six months.

Companies

Penick & Ford, Ltd., wants to acquire Morningstar-Paisley, Inc., and operate it as a division. If they approve the proposal, common shareholders of the latter firm would get 0.385 shares of Penick & Ford for each share they now own.

Union Oil Co. of California has bought American Liquid Gas Corp., Los Angeles. Purchase price was not disclosed. Two new Union Oil subsidiaries have been created to absorb American Liquid's operations: Algas Fuel Supply Co. and American Liquid Gas Engineering & Equipment Co.

Natural Gas Processors Assn. is the new name of Natural Gasoline Assn. of America. The organization has had five names since its founding as Assn. of Casinghead Gasoline Manufacturers, in 1921.

The United States Stoneware Co., Akron, Ohio, has purchased the Chemical Equipment Dept. of Indiana General Corp.'s General Ceramics Div. Sale includes inventories, patents, machinery and hardware used to make Indiana General's line of pumps, chemical stoneware and ceramic products.

International

Kuwait has released the following details of the sheikdom's petrochemicals project on the Persian Gulf: (1) initial annual outputs will be 31,400 tons of caustic soda, 42,000 tons of polyvinyl chloride, and 156,000 tons of urea; (2) Kuwait Petrochemicals Co., Ltd., cap-

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FEDERATED ZINC DUST

Now being used as a reducing agent, precipitating agent, purifier, catalyst, polymerizing agent, and in rust-resistant paints, bleaches, pyrotechnics, soot-removal, pipe thread compounds, and Sherardizing, zinc dust often does a better job than other compounds at less cost. Federated Zinc Dust is 97% metallic zinc, with a 97% through 325 mesh screen fineness. Send for half-pint experimental lot, and call on Federated's research and engineering assistance. Write or call: Federated Metals Division, American Smelting and Refining Company, 120 Broadway, New York 5, N. Y. or your nearby Federated sales office.

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SAN FRANCISCO 24, CALIF.
Atwater 2-3340

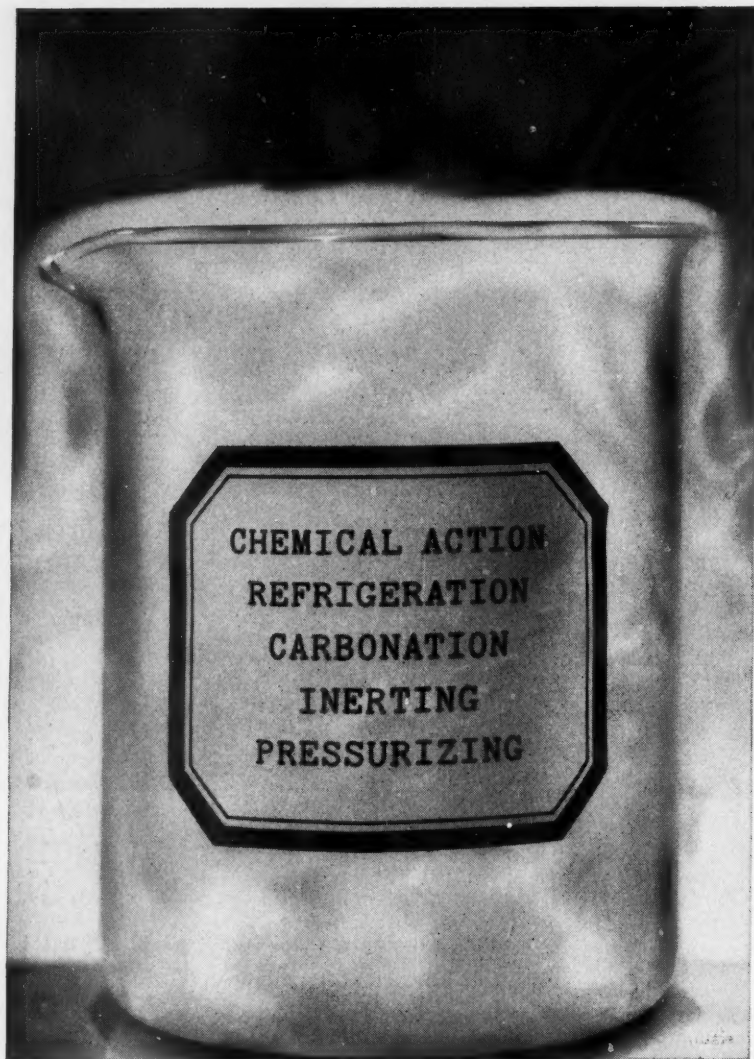
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CHEMICALS DIVISION **Olin**

CPI NEWS BRIEFS . . .

italized at \$45 million, has been created by Italy's Oronzio de Nora, in consort with the sheikdom and a handful of minority private interests, to back the complex; (3) newly independent Kuwait had originally solicited participation in the project from several American and British companies, but were turned down "for reasons we do not know," says Ahmed el-Sayed Omar, deputy director of Kuwait's Finance Dept.

Great Britain: Imperial Chemical Industries Ltd. has licensed routes to caprolactam and nylon-6 from Emser Werke A.G./Inventa A.G. in Switzerland. Construction of a 15,000-ton/yr. caprolactam plant and companion large-scale nylon unit will begin shortly at ICI's Severnside, England, site.

Canada: Canadian Oil Companies Ltd. has brought the country's first Hydeal unit on stream at Sarnia, Ont. The installation turns out 350 bbl./day of benzene from toluene, doubling the firm's previous 3.5-million-gal./yr. benzene capacity at the site. It was built by Procon (Canada) Ltd., a subsidiary of Universal Oil Products Co.

Spain: Instituto Nacional de Industria (INI), state-owned holding company, plans a petrochemical complex at its shale-oil refinery in Calvo Sotelo, Puertollano. An additional 22,000-bbl./day crude-oil refinery is planned to feed the 275,000-ton/yr. petrochemical facility, products of which have not been disclosed. Also on the drawing boards is a 50,000-bbl./day, Malagato-Puertollano crude pipeline.

Belgium: Centre d'Etude de l'Energie Nucleaire (CEN), owner-operator of the 50-mw. water-cooled nuclear reactor at Mol, reports that the unit has gone critical. United Nuclear Corp., New York, designed and built the \$20-million BR-2 reactor. Euratom (European Atomic Energy Community) will share in the \$2.5-million annual costs of operating the installation, which boosts the free world's nuclear materials and



A WESTERN APPROACH

met

didn't like...



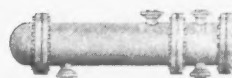
Will Rogers

Will Rogers expressed the heart and soul of our country and its people. If it's remarkable that he never met a man he didn't like — it's even more remarkable that there was never a man that didn't like him. Will Rogers dedicated his life to service to his countrymen.

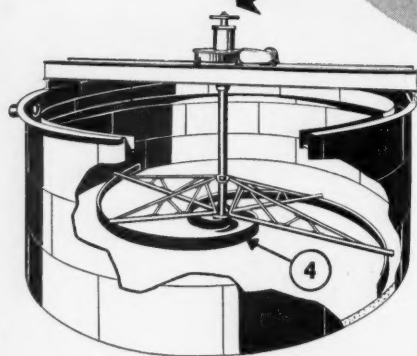
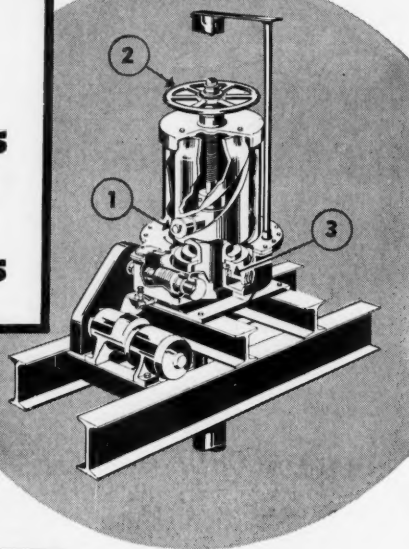
... at Western, we, too, are dedicated to service to the petroleum and petrochemical industries. We like the people we deal with, and we hope our high standards of design, engineering and fabricating merit their confidence.

The Heat Exchanger Division of Western Supply Co. designs and fabricates Fixed Tube Sheet, U-Tube, and Floating Head Exchangers. We're specialists in heat-transfer problems. We hope we may work with you, serving in the fields we know best.

WESTERN
HEAT EXCHANGERS
WESTERN SUPPLY COMPANY
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2. Manual or power raise.
3. Replaceable ring-type ball bearing support.
4. Spiral rakes, and "froth rings."

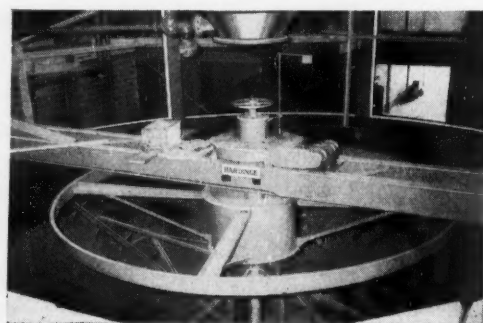
The higher the solids content in the thickener underflow, the lower the cost of filtering for subsequent processing or disposal.

The spiral rakes of the Hardinge Thickener compress the solids to maintain high density of underflow.

The "Auto - Raise" drive mechanism prevents overloading as the underflow is thickened.

Submerged parts may be supplied with rubber or lead covering or fabricated from wood or any metal available for structural parts.

Complete specifications upon request.
Bulletin 31-D-11.



Also available are "froth rings" for froth-free overflow and superposed type tank construction (as shown above) for minimum floor space and building economy.

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CPI NEWS BRIEFS . . .

testing capability by almost 50%. Only known comparable facilities are the AEC's MTR and ETR units at the National Reactor Test Station in Idaho.

Canada: Gypsum, Lime & Alabastine Ltd., a subsidiary of Dominion Tar & Chemical Co., plans a \$2-million expansion of its lime plant at Joliette, Que. New rotary kiln, stone crushing and screening units will increase capacity by 200 tons, to 1 million tons daily.

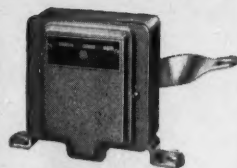
Sweden's atomic energy commission, Atomenergi A/B, has begun initial studies to determine the feasibility of building a 250-mw. nuclear power plant. Study will take eight months, is being made by A. Johnson Co., Stockholm; Bechtel Corp., San Francisco; and Westinghouse Electric International Co., Pittsburgh.

Portugal: Sociedade Anonima Concessionaria de Refinacao de Petroleos em Portugal (SACOR), state-held refining concession, plans a 20,000-bbl./day refinery at Oporto. Due on stream in 1963, installation will be the country's second refinery (the other is at Cabo Ruivo, near Lisbon, capacity for which is currently being stepped up from 26,000 to 30,000 bbl./day).

Israel's state-owned Negev Phosphates Co. is embarking on a \$20-million expansion project, only 50% of which it will own (a group of undisclosed foreign chemicals firms controlling the balance). Program calls for construction (tentatively at Oron) of calcination and byproduct plants, to make 200,000 tons of calcinated phosphates, 60,000 tons of soda ash, 140,000 tons of phosphate-concentrate fertilizers, and 100,000 tons of triple superphosphate annually. About 70% of the output will be exported.

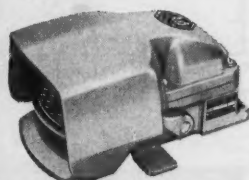
Australia: Alcoa of Australia (Pty.) Ltd. has been created by Aluminum Co. of America and a group of undisclosed Australian firms, to establish and operate a \$100-million aluminum project at several sites on the continent. Due to begin operations in the

Your A-B Handy Catalog Lists These Control Devices Often Considered "Special"



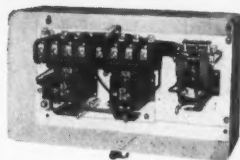
BULLETIN 840
Float Switches

These quality switches are available in a wide range of types for automatic control of motors operating tank or sump pumps. The snap-action switch mechanism assures positive operation, no matter how slowly the liquid level changes.



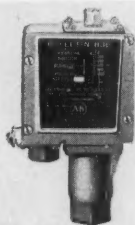
BULLETIN 805
Foot Switches

Ruggedly built to withstand the most severe industrial usage. Snap-action switch mechanism features maintenance free silver contacts. The foot switch shown above assures complete "safety" for the operator. Also made without top guard.



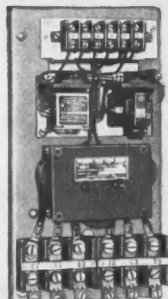
BULLETIN 1270
Automatic Transfer
Switches

These switches are designed to transfer power-load to standby supply when normal power fails or drops too low. Automatically returns load to normal supply when power is resumed. Mechanically interlocked.



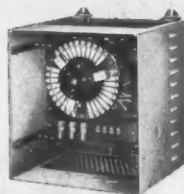
BULLETIN 836
Pressure Controls

For machine tool hydraulic systems operating at pressures up to 5000 psi. Oiltight enclosure. Operating pressure and differential are adjustable. A visible indicator shows trip point. Maintenance free silver contacts.



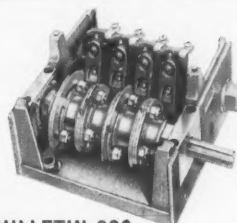
BULLETIN 812
Phase Failure—Phase
Reversal Relays

Style F relay (above) protects against all open phase conditions on a branch motor circuit. Style R disconnects the motor upon a phase reversal. Style RF gives phase failure and phase reversal protection.



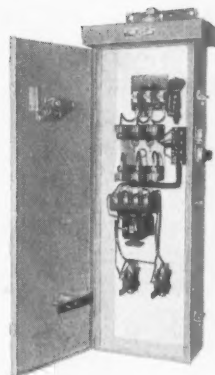
BULLETIN 555
Speed Regulators

Provide manual speed control of wound rotor motors for either fan or machine duty. When used with magnetic starter, the first step closes control circuit.



BULLETIN 803
Rotating Cam
Limit Switches

Heavy-duty controls for use on automatic production machines. Made with up to 12 independent circuits which can be separately adjusted for operation at any point of rotation.



BULLETIN 1232
Pump Control Panels

Complete units for automatic operation of irrigation and oil well pumps. Employ standard A-B Bulletin 709 magnetic starter with manual disconnect switch or circuit breaker in weatherproof enclosure. Wide variety of optional features available.



BULLETIN 365
Multi-Speed
Drum Switches

Designed for manual starting, speed changing, and reversing of poly-phase multi-speed motors. Made for up to four speeds either non-reversing or reversing.

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TERRIFIC!

**— and how long will the
flexing member last?**

Good question. The heart of Para-flex is a tire with synthetic tension members bonded together in rubber—which provides a flexing body that automatically compensates for all combinations of misalignment and end float, and absorbs vibration as well!

This amazing coupling has now been used in American industry 4 years. Thousands are in operation—in food processing plants, paper mills, chemical plants, textile mills, everywhere—and in these 4 years, replacements of elements have been negligible.

Dodge Standard Para-flex takes angular misalignment up to 4°, parallel misalignment up to 1/8" and end float up to 5/16" depending upon the size of the coupling and the duration of shaft displacement.

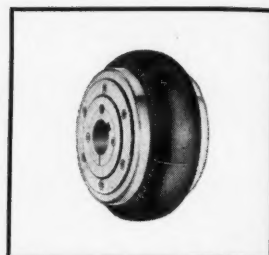
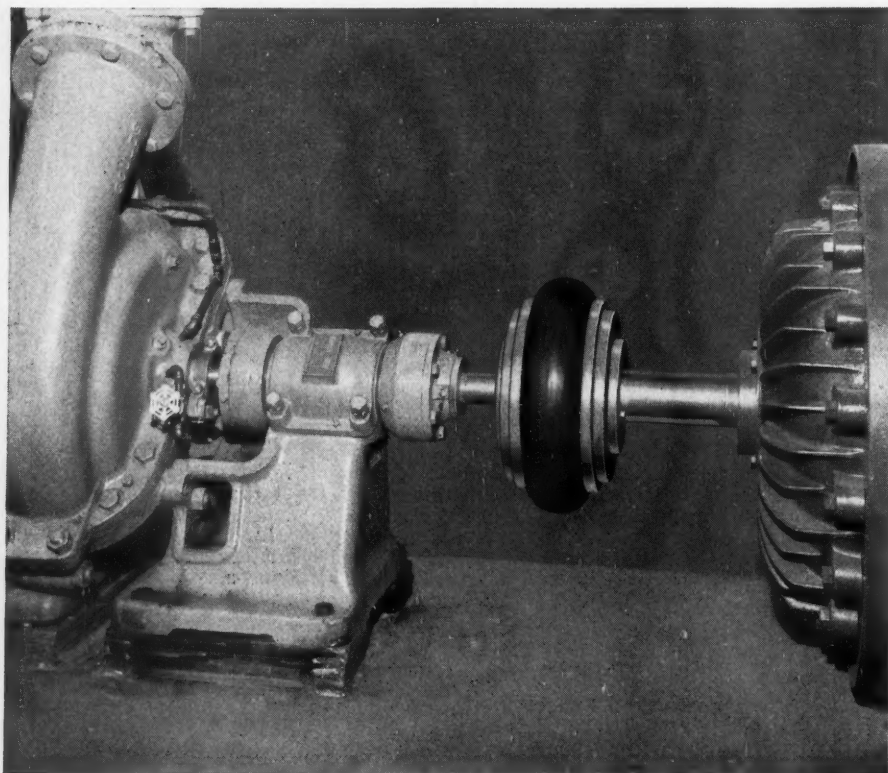
Dodge Para-flex is available in 3 types—Standard, Flywheel and High Speed (shown at right). The Standard type is stocked in capacities up to 3640 hp at 910 rpm. Ask your Dodge Distributor, or write us for complete technical bulletin.

Dodge Manufacturing Corporation, 200 Union Street, Mishawaka, Indiana

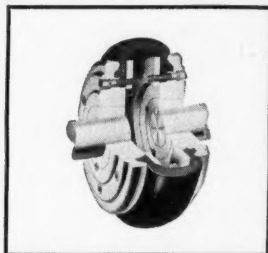
The Products with the Pluses...

DODGE

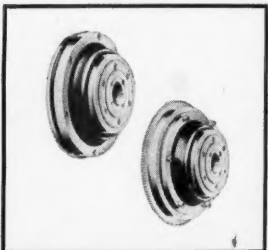
of Mishawaka, Ind.



The new idea in flexible cushion couplings, with a flexing member that "swallows up" misalignment.



No lubrication, no maintenance. Replace flexing element without moving driver or driven machine.



Flywheel and High Speed Types. For use with motors and internal combustion engines turning up to 5230 rpm.

DODGE

Para-flex

CALL THE TRANSMISSIONEER,
your local Dodge Distributor. Factory trained by Dodge he can give you valuable assistance on new cost-saving methods.

middle of 1963, the program calls for: (1) bauxite mining and alumina extracting near Perth, on Australia's western coast; (2) transporting the alumina 1,700 mi. by sea to the port of Geelong, near Melbourne; (3) aluminum smelting at Geelong, in a 40,000-long ton/yr. unit; (4) alloying and fabricating into sheet, foil, tube and other mill and extruded forms at Geelong.

West Germany: Esso A.G., Hamburg, plans a \$45-million refinery near Ingolstadt. The 40,000-bbl./day installation is the third announced for the area (others are planned by Suedpetrol A.G., an offshoot of Italy's state-owned ENI, and Deutsche Shell A.G.). Suedpetrol's facility is due on stream in the middle of 1963, about half a year ahead of the other two.

Canada: Aluminum Co. of Canada, Ltd., a subsidiary of Aluminium Ltd., plans to double its capacity for rolled aluminum sheet by constructing an \$11-million, 30,000-ton/yr. mill at Kingston, Ont. Facility is due on stream by the end of next year.

Sweden: Svenska Metallverken A/B has acquired full ownership of Svenska Aluminiumkompaniet A/B from Aluminium Ltd. in Canada. Delicate deal involves a \$7-million cash payment by Svenska Metallverken to Aluminium Ltd., in return for which the Canadian firm surrenders its half interest in Svenska Aluminiumkompaniet but acquires a "larger interest" in Svenska Metallverken, the parent firm (in which Aluminium Ltd. is already a substantial shareholder). Largest aluminum fabricator in Sweden, Svenska Metallverken captively processes all 16,500 tons/yr. of metal that Svenska Aluminiumkompaniet smelts. Aluminium Ltd. will continue to supply the alumina raw material.

Great Britain: Air Products, Inc., Allentown, Pa., has paid \$2.5 million to acquire 100% interest in its British subsidiary, Air Products Ltd., from Butterley Co., London. Air Products Ltd. is headquartered

in Ripley, Derbyshire; makes cryogenic hardware at Acrefair in northern Wales.

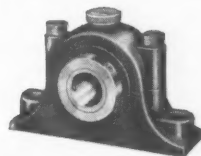
Japan: Mitsui Chemical Industry, Toyo Koatsu, and General Bussan have grouped together in an apparently loose affiliation to "collectively manufacture oils and chemical products." The petrochemical scheme follows the lead of the Idemitsu Kosan linkage, which saw Toyo Rayon and Toa Gosei joined with Idemitsu Kosan, largest independent oil refiner in the country. General Bussan is said to be planning a 100,000-bbl./day refinery on the Nagoya waterfront, to supply 100,000 tons of ethylene, 30,000 tons of propylene, and 15,000 tons of acetylene annually to Mitsui Chemical and Toyo Koatsu. Mitsui is reported to be mapping out a sprawling synthetics project, at which would be produced raw materials for Tetoron fiber, polypropylene and other resins. Toyo Koatsu recently placed a polyurea fiber unit on stream at Hokkaido.

Japan: A joint subsidiary, as yet unnamed, has been created by Yoshitomi Pharmaceutical Industries, Ltd., Osaka, and Wallace & Tiernan Inc.'s Lucidol Div., Buffalo, N. Y. New firm will make Lucidol's catalysts for high-pressure polyethylene. Release of site, capacity and cost information await approval of MITI, Japan's industrial regulatory agency.

Poland: An 185-mi. pipeline will be built to carry sulfur-free Soviet gas from Daszawy, near Lvov in the Ukraine, to Poland's projected petrochemical complex at Pulav, Lublin Province (*Chem. Eng.*, Nov. 14, 1960, p. 268). Facilities will make acetylene to feed an 80,000-ton/yr. polyvinyl chloride unit, a 15,000-ton/yr. installation for synthetic fiber intermediates, and a 500,000-ton/yr. nitrogenous fertilizer plant. First stage is slated to go on stream by early 1966, second by 1967.

West Germany: The Continent's first privately financed nuclear power is now being generated at

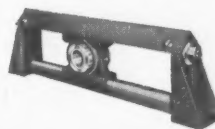
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Maximum strength with minimum weight!



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Complete range of stock models, sizes.

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WHY VENT DOLLARS TO THE ATMOSPHERE?

Use a QUIK-SERT to eliminate the loss

Why let profits escape into thin air when there's such a practical way to save them? You know that a safety valve can't always stop leakage. And many toxic, inflammable or odorous gases are hard to seal. That's why you need a Quik-Sert. This BS&B Rupture disc gives you absolute tight shutoff. Nested in its mounting under the safety valve, it protects the valve from corrosive action and, thus, cuts down valve maintenance.

The BS&B Quik-Sert is a completely trouble-free safety device. Teamed with a safety valve, it is a fool-proof way to eliminate vapor loss and reduce valve maintenance.

For descriptive literature on BS&B Quik-Sert, write to Black, Sivalls & Bryson, Inc., 7500 East 12th St., Kansas City, Missouri.



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CPI NEWS BRIEFS . . .

Kahl, near Frankfurt. The boiling-water reactor was built by General Electric for Bayernwerk A.G. and Rheinisch-Westfaelisches Elektrizitatswerk, two of West Germany's largest utility companies. The 15-mw. station will be used for both power generation and research.

Japan: Nihon Gas Kagaku Kogyo K.K. has signed Chemical Construction Corp. to redesign a urea plant at Niigata. Chemico's total-recycle carbamate process will boost capacity from 80 to 150 metric tons/day.

People

Robert P. Barnett, Robert J. Reilly, Walter H. C. Rueggeberg and W. Spencer Thompson have been elected vice presidents of Atlas Chemical Industries, Inc. Rueggeberg continues as director of research and development.

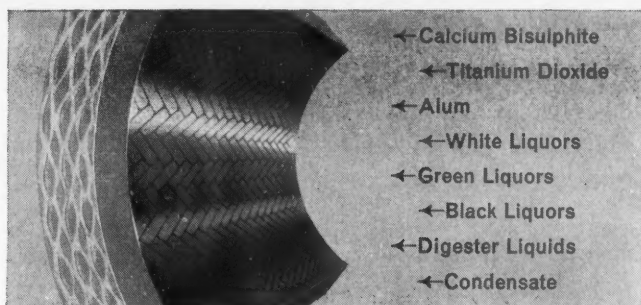
William B. Humes has been appointed president of Union Carbide Plastics Co., replacing the late **R. K. Turner**, who passed away suddenly at his home less than a month after being promoted to a vice presidency with the parent firm, Union Carbide Corp.

Piero Giustiniani, managing director of Italy's Montecatini, has been elected a director of Minerals & Chemicals Philipp Corp. The news followed an announcement that Montecatini and its associates had privately purchased "an important holding" of M&CP's shares.

Donald E. Hudgin has been appointed director of research for polymers at Diamond Alkali Co.

John S. Atwood has been named assistant to the vice president of Koppers Co.'s Plastics Div.

Clifford E. Weber is the new director of fuels and materials for Atomics International, a division of North American Aviation, Inc.



CORROSION-RESISTANT TO CHEMICAL ATTACK—Used in many of the major paper and pulp plants, Fibercast now has proved itself to be a corrosion-free, non-contaminating piping system. It has outstanding ability to withstand damaging, corrosive liquids under high pressures and temperature extremes.

FIBERCAST® pipe combats critical corrosion problems in the paper industry!

- *Copes with temperature range from -65° to $+300^{\circ}$ F.*
- *Withstands operating pressure range to 1200 psi.*
- *Handles 320 of the hottest 338 corrosive solutions.*
- *Available in pipe sizes from 2" to 8" with fittings.*

Heat, pressure, and corrosion failures can cost your paper mill money—in downtime, intermittent tubing replacements, high costs for new materials and labor.

That's why it is important for you to evaluate the solid cost-cutting protection you get with Fibercast pipe. Fibercast solves your piping problems better than any other tubing. Even more expensive pipe, or pipe with thermoplastic interior coatings cannot match Fibercast's resin rich interior.

The "hot" acids, liquids and other corrosive solutions, unique to the pulp and paper industry have negligible effect on this rugged pipe. Whether used in dryer drainage systems, reaction tower installations, or in carrying such solutions as calcium bisulphite, Fibercast proves long-lasting, safe, efficient.

The Secret of Long Service Life

Fibercast owes its long service life—and its special resistance to heat, pressure, corrosion and contamination—to the exclusive way it is built. Fibercast is a centrifugally cast thermoset epoxy reinforced pipe with multiple layers of seamless braided glass fiber sleeving or especially woven glass fab-

ric. A body of woven glass fibers, impregnated with epoxy resin chemically cured at elevated temperatures, gives Fibercast its outstanding ability to withstand high pressures and temperatures in corrosive environments.

COMPARATIVE LIFE DATA*

FIBERCAST, GRADE J	1.00
ALUMINUM	.26
BRASS (RED)	.74
RUBBER HOSE	.210
STEEL (Stainless 304-40)	.311
ASBESTOS (Cement-C-100)	.237

*Basing Fibercast as unit life of 1 and others as comparative percentages thereof.

Fibercast handles operating pressures to 1200 psi. It has an operating temperature spread wider than any other non-metallic pipe (-65° to $+300^{\circ}$ F.). It handles 320 of 338 (94%) known corrosive solutions.

Reputation For Safety

The Fibercast reputation for safety is another vital factor important to

you. Most piping materials wear undetectably from the inside-to-outside and can suddenly burst without warning, inflicting injury to personnel and adjacent facilities.

Because of Fibercast's woven glass fiber constructions, such occurrences of "inside-to-outside" wear, if they ever occur, are detectable in minute "bleeding," easily repaired leaks.



Complete Fibercast systems are available in sizes from 2" to 8" O.D. And only Fibercast offers the world's most complete line of non-metallic, epoxy fittings.

Find out how Fibercast pipe can help you control costly corrosion problems in your plant. Return the coupon below and get the facts now.

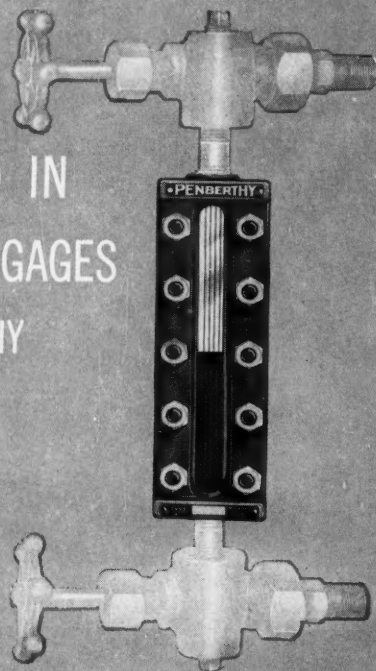
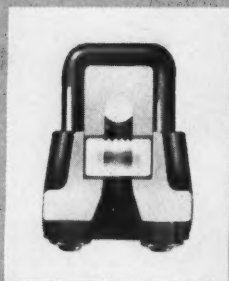
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Certainly, your *first* requirement of a gage for determining liquid levels in tanks, pressure vessels, boilers, evaporators and other fluid containers is *Accuracy*. The design, materials and craftsmanship incorporated in the construction of Penberthy liquid level gage sets *guarantee* you clearer visibility, unmatched accuracy . . . at temperatures from sub-zero to 750°F. And Penberthy stands behind that statement with a 74-year reputation for unquestioned leadership in gage development and manufacturing.

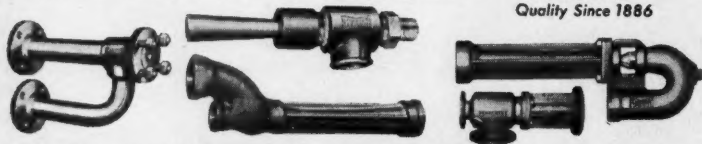
You may be sure, too, that Penberthy gages are built to simplify service, reduce maintenance, minimize blowout hazard and, above all, to last longer. Want more information? Mail coupon today.

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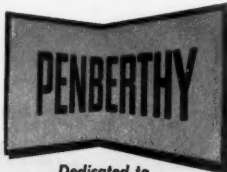
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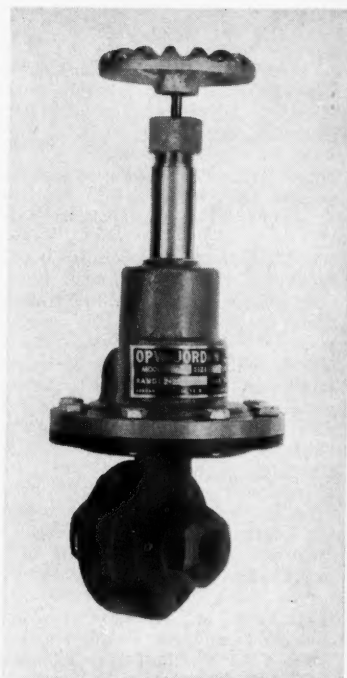


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NEW EQUIPMENT . . .

continued from page 90

manual and motorized operation in $\frac{1}{8}$, $\frac{1}{4}$, $\frac{3}{8}$ and $\frac{1}{2}$ -in. sizes for use up to 1,000 psi. Construction is of type 316, 394, or other stainless steels, with Teflon seats and packing as standard equipment. A wide range of interchangeable end pieces can be used for connection. — Cooper Alloy Corp., Hillside, N. J. 90E

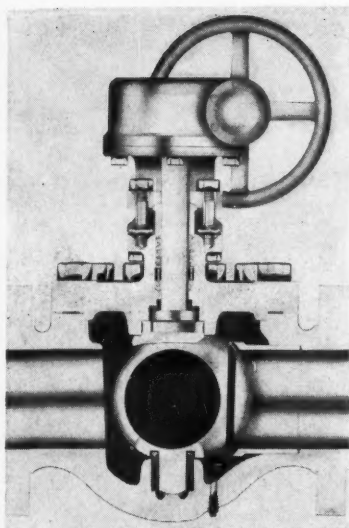


Differential regulator

All-metal unit has self-cleaning, self-lapping sliding gate seats.

A pressure-differential regulator maintains a constant differential between any medium loaded on top of the diaphragm and any other medium passing through the device. It is suitable for steam, air, water, oil, gas or chemicals.

Designed for 250 psi. at 450 F., 300 psi. at 150 F., the unit provides differential pressures up to 125 psi., with control ranges of 2-30, 15-70, 20-85 and 40-170 psi. Ductile iron and bronze valves are available from $\frac{1}{4}$ to $\frac{3}{4}$ -in.—OPW-Jordan Corp., Cincinnati. 166A



Ball valve

Stem-lift action permits use of metal-to-metal seating surfaces.

An eccentric cam action of the stem lifts the ball away from the seat in this valve, eliminating sliding friction that may score the seat. This feature permits use of hard metal-to-metal seating surfaces, which aids in tight shutoff and allows the valve to serve at temperatures and under radioactive conditions that would destroy plastic seat rings on conventional ball valves.

The valve is designed for full-round flow, equal to full-pipe area for a given size, and has a locking action that insures tight shutoff even when line pressure is reversed. Valve is available in a wide range of sizes and pressure classes with manual, pneumatic, electric or hydraulic operators.—General Kinetics Corp., Englewood, N. J. 167A

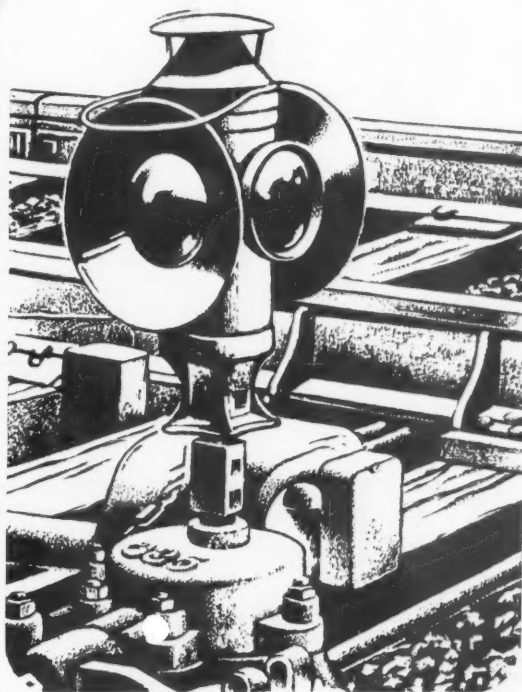
Nitrogen generator

Unit provides liquid N_2 continuously for laboratory, industrial use.

Controlled by a simple on-off pushbutton, the Model LN-20 produces liquid nitrogen at a rate of 20 lb./hr., whether discharging into a pressurized vessel or into an open Dewar flask. Liquid



Why switch?



Key chemical transportation for chlorine and caustic

Once by rail, always by rail? Not necessarily. Changes in tonnage, freight rates, or facilities for storage may make a switch to barge shipment of chlorine or caustic a wise move. This is something we check carefully—and often—for our customers. With our Wyandotte plant at the hub of the Great Lakes, and our Geismar plant near the mouth of the Mississippi—we are ideally situated to ship by barge, rail, or truck. Call us.

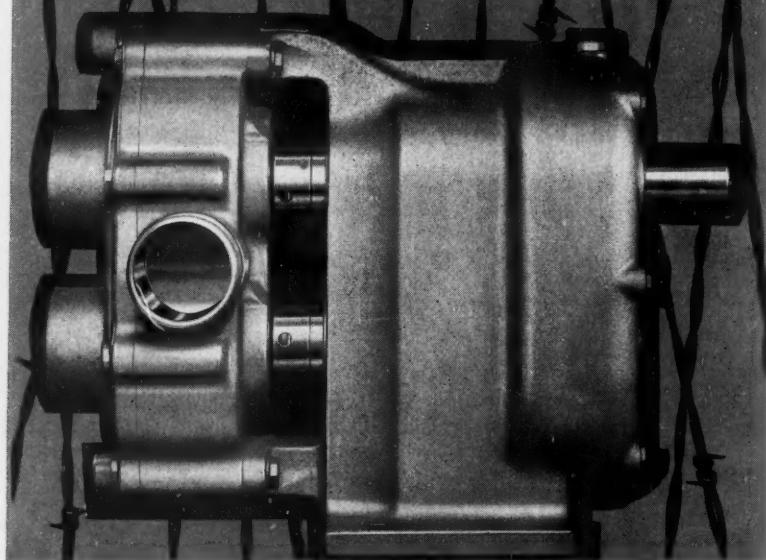
WYANDOTTE

CHEMICALS



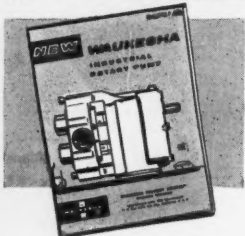
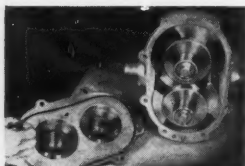
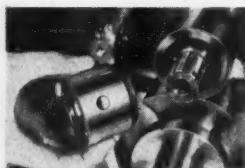
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pumping through corrosion barriers



WAUKESHA ROTARY PUMP FOR CORROSION PROBLEM LIQUIDS OR SEMI-LIQUIDS!

Damaging corrosives, problem liquids of varying viscosities are kept on stream with Waukesha industrial rotary pumps.



FEATURES

- All 316 stainless steel heavy duty construction. Rotors are patented Waukesha alloy with corrosion-resistance comparable to 316 stainless steel.
- High efficiency — close tolerance because of special alloy rotors.
- Field interchangeability of packing gland or mechanical seal (single or dual).
- Quick disassembly of pump head (liquid end) without special tools.
- Simplicity of design facilitates field maintenance.
- Optional pipe threaded or flanged connections.



Write for catalog P-333,
Waukesha Foundry Co., Dept. 91E, Waukesha, Wis.

EXPORT SALES: FMC International, Box 1178,
San Jose, California, U. S. A.

Convention Calendar

September

3-8. American Chemical Society, National Meeting, Chicago, Ill.

5-8. 11th National Chemical Exposition, International Amphitheater, Chicago, Ill.

6-8. Assn. for Computing Machinery, Annual Meeting, Statler-Hilton Hotel, Los Angeles, Calif.

6-8. Massachusetts Institute of Technology, International Symposium on Transmission and Processing of Information, Cambridge, Mass.

7-8. The Combustion Institute, Western States Section, Fall Meeting, University of California, Berkeley, Calif.

11-15. Instrument Society of America, 16th Annual Instrument, Automation Conference & Exhibit, Biltmore Hotel and Memorial Sports Arena, Los Angeles, Calif.

11-15. National Industrial Conference Board, Stanford Research Institute, International Industrial Conference, Fairmont Hotel, San Francisco, Calif.

12-15. Pennsylvania State University, Seminar for Manufacturing Engineers, University Park, Penna.

14-15. American Society of Mechanical Engineers, American Institute of Electrical Engineers, Engineering Management Conference, Hotel Roosevelt, New York, N. Y.

17-22. Pennsylvania State University, Work Measurement Course, University Park, Penna.

18-20. Canadian Agricultural Chemicals Assn., 9th Annual Meeting and Conference, Mont Tremblant Lodge, Mont Tremblant, Que.

18-20. Standards Engineers Society, Annual Meeting, Hotel Sherman, Chicago, Ill.

22-1. 1st International Plastics Fair of Denmark, Forum, Copenhagen, Denmark.

24-27. American Institute of Chemical Engineers, National Meeting, Lake Placid, N. Y.

24-27. American Society of Mechanical Engineers, Petroleum Mechanical Engineering Conference, Muehlebach Hotel, Kansas City, Mo.

24-27. American Institute of Electrical Engineers, American Society of Mechanical Engineers, National Power Conference, St. Francis Hotel, San Francisco, Calif.

25-28. American Welding Society, Fall Meeting, Adolphus Hotel, Dallas, Tex.

25-28. Industrial Building Exposition & Congress, New York Coliseum, New York, N. Y.

28-29. American Production and Inventory Control Society, 4th Annual National Conference and Technical Exhibit, Pick-Congress Hotel, Chicago, Ill.

28-30. American Society for Quality Control, Chemical Div., 5th Annual Chemical Conference, Daniel Boone Hotel, Charleston, W. Va.

October

2-3. Engineers Council for Professional Development, 29th Annual Meeting, Sheraton Seelbach Hotel, Louisville, Ky.

2-7. International Astronautical Federation, 12th International Astronautical Congress, Washington, D. C.

4-6. American Society of Mechanical Engineers, Process Industries Conference, Shamrock-Hilton Hotel, Houston, Tex.

5-7. American Society of Mechanical Engineers, American Institute of Mining, Metallurgical and Petroleum Engineers, 24th Annual Joint Solid Fuels Conference, Dinkler-Tutwiler Hotel, Birmingham, Ala.

6-7. American Society for Engineering Education, Annual North Midwest Meeting, Michigan College of Mining and Technology, Houghton, Mich.

8-11. American Institute of Mining, Metallurgical and Petroleum Engineers, Society of Petroleum Engineers, Fall Meeting, Dallas, Tex.

8-12. Water Pollution Control Federation, Milwaukee Auditorium and Schroeder Hotel, Milwaukee, Wisc.

9-11. Technical Assn. of the Pulp & Paper Industry, Plastics Paper Conference, French Lick-Sheraton Hotel, French Lick, Ind.

9-15. American Rocket Society, Space Flight Report to the Nation, New York Coliseum, New York, N. Y.

11-12. CHEMICAL ENGINEERING and Armour Research Foundation, Conference on the New Trends in Chemistry, Sheraton Towers Hotel, Chicago, Ill.

Later

November 27-December 1. 28th Exposition of the Chemical Industries, New York Coliseum, New York, N. Y.



Need help?



Key chemical ideas for chlorine and caustic

Wyandotte technical service is a wonderful source of ideas. It saved a brewery at least \$26,000 a year in caustic costs by recommending a switch to liquid. It helped a paper manufacturer get fibers of virgin-pulp quality from waste paper by cooperating in the development of a new 3-stage bleaching process. It could help you to new and better things with key chemicals. Why not call us in?

WYANDOTTE

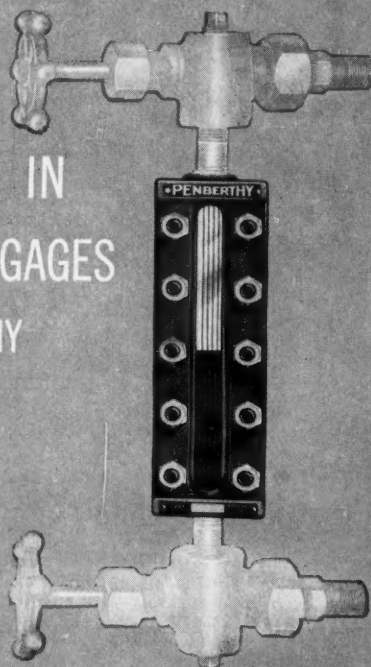
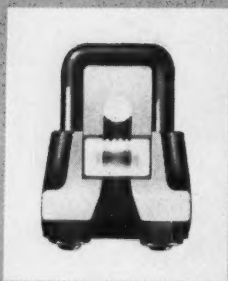
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MICHIGAN ALKALI DIVISION, WYANDOTTE, MICHIGAN

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Certainly, your *first* requirement of a gage for determining liquid levels in tanks, pressure vessels, boilers, evaporators and other fluid containers is *Accuracy*. The design, materials and craftsmanship incorporated in the construction of Penberthy liquid level gage sets *guarantee* you clearer visibility, unmatched accuracy . . . at temperatures from sub-zero to 750°F. And Penberthy stands behind that statement with a 74-year reputation for unquestioned leadership in gage development and manufacturing.

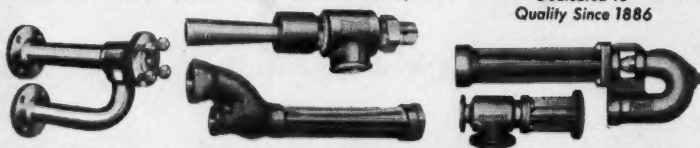
You may be sure, too, that Penberthy gages are built to simplify service, reduce maintenance, minimize blowout hazard and, above all, to last longer. Want more information? Mail coupon today.

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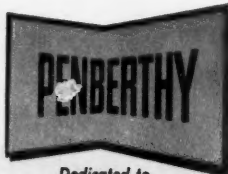
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NEW EQUIPMENT . . .

continued from page 90

manual and motorized operation in $\frac{1}{8}$, $\frac{1}{4}$, $\frac{3}{8}$ and $\frac{1}{2}$ -in. sizes for use up to 1,000 psi. Construction is of type 316, 394, or other stainless steels, with Teflon seats and packing as standard equipment. A wide range of interchangeable end pieces can be used for connection. — Cooper Alloy Corp., Hillside, N. J. 90E

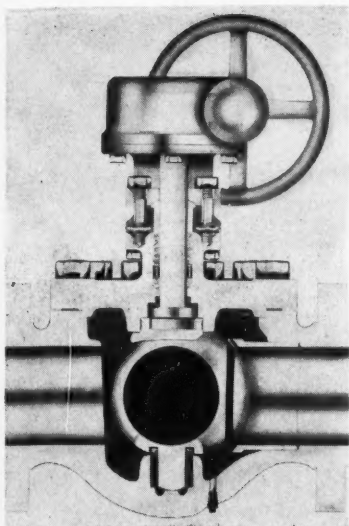


Differential regulator

All-metal unit has self-cleaning, self-lapping sliding gate seats.

A pressure-differential regulator maintains a constant differential between any medium loaded on top of the diaphragm and any other medium passing through the device. It is suitable for steam, air, water, oil, gas or chemicals.

Designed for 250 psi. at 450 F., 300 psi. at 150 F., the unit provides differential pressures up to 125 psi., with control ranges of 2-30, 15-70, 20-85 and 40-170 psi. Ductile iron and bronze valves are available from $\frac{1}{4}$ to $\frac{3}{4}$ -in.—OPW-Jordan Corp., Cincinnati. 166A



Ball valve

Stem-lift action permits use of metal-to-metal seating surfaces.

An eccentric cam action of the stem lifts the ball away from the seat in this valve, eliminating sliding friction that may score the seat. This feature permits use of hard metal-to-metal seating surfaces, which aids in tight shutoff and allows the valve to serve at temperatures and under radioactive conditions that would destroy plastic seat rings on conventional ball valves.

The valve is designed for full-round flow, equal to full-pipe area for a given size, and has a locking action that insures tight shutoff even when line pressure is reversed. Valve is available in a wide range of sizes and pressure classes with manual, pneumatic, electric or hydraulic operators.—**General Kinetics Corp., Englewood, N. J. 167A**

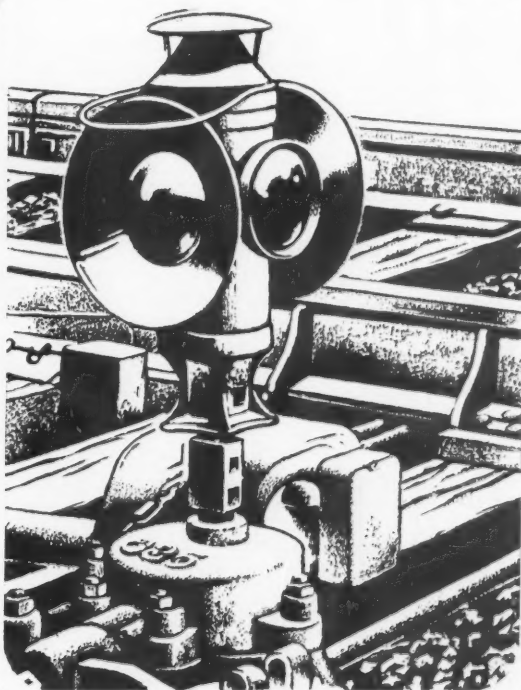
Nitrogen generator

Unit provides liquid N_2 continuously for laboratory, industrial use.

Controlled by a simple on-off pushbutton, the Model LN-20 produces liquid nitrogen at a rate of 20 lb./hr., whether discharging into a pressurized vessel or into an open Dewar flask. Liquid



Why switch?



Key chemical transportation for chlorine and caustic

Once by rail, always by rail? Not necessarily. Changes in tonnage, freight rates, or facilities for storage may make a switch to barge shipment of chlorine or caustic a wise move. This is something we check carefully—and often—for our customers. With our Wyandotte plant at the hub of the Great Lakes, and our Geismar plant near the mouth of the Mississippi—we are ideally situated to ship by barge, rail, or truck. Call us.

WYANDOTTE

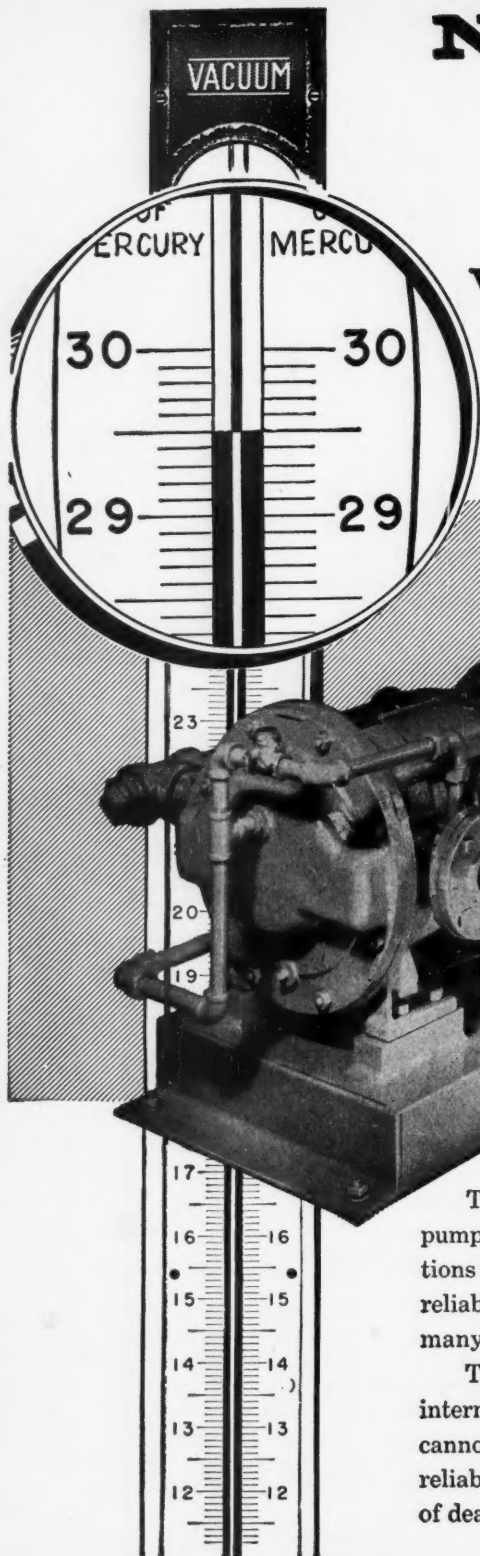
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MICHIGAN ALKALI DIVISION, WYANDOTTE, MICHIGAN

NASH PUMPS for higher Vacuums

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The effective vacuum range of these Nash Air Ejector equipped pumps is extended to 0.5" Hg. absolute. For high vacuum applications where hard to handle service conditions are present and where reliability of pump operation is imperative. These pumps can handle many saturated or wet gases including solvent and acid vapors.

These pumps have but one internal moving part, and use no internal lubrication. The vacuum produced is non-pulsating. They cannot be damaged by a slug of liquid, and will provide the same reliability and long life even if the operating cycle consists mostly of dead end service. Please request Bulletin 387-A.

NASH ENGINEERING COMPANY
SOUTH NORWALK, CONNECTICUT, U. S. A.

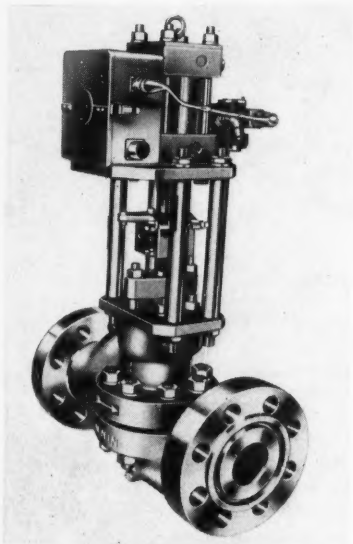
NEW EQUIPMENT . . .

nitrogen is available 90 min. after a warm start or 20 min. after starting from an overnight shut-down.

The machine is designed for easy installation, being small enough to pass through a standard doorway and requiring no special foundation. However, it does require 3 gpm. of water for cooling. Power consumption: 0.77 kwh./lb. nitrogen.

The LN-20 incorporates two interconnected units: the compressor includes a single-stage process air compressor and a two-stage nitrogen booster compressor; the generating unit consists of an insulated enclosure containing an expansion engine, four main heat exchangers and a distillation column.

Also available in the same series are two larger models: the LN-100 (100 lb./hr.) and the LN-400 (400 lb./hr.).—Joy Mfg. Co., Pittsburgh. 167B



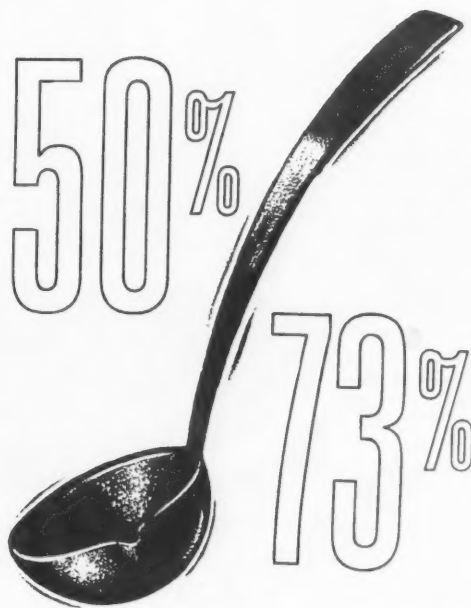
Valve actuator

Electrical signal is rapidly converted to hydraulic force.

Any suitable electrical signal from an automatic or manual control station is quickly converted to hydraulic force in this valve actuator that offers high fre-



Which grade?



Key chemical selection in liquid caustic

A key chemical is the best buy. Case in point: liquid caustic. We offer it in two concentrations . . . 50% and 73%. Today, your best buy may be the 50% grade. If so, that's what we'll recommend—today. But if stepped-up use of caustic or changes in freight rates alter your economic position in the future—we'll recommend conversion. We never consider our first analysis final . . . and never stop working with you.

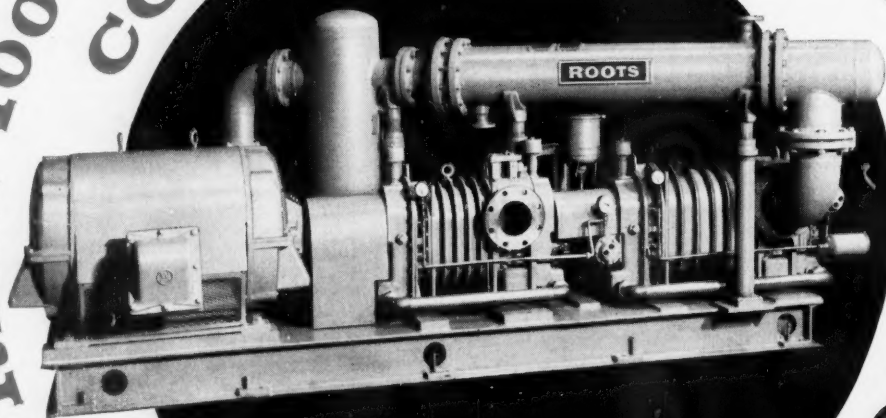
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MICHIGAN ALKALI DIVISION, WYANDOTTE, MICHIGAN

RIDE THE DOWNWARD SPIRAL IN 100 LB. AIR WITH THIS NEW ROOTS C-100 COMPRESSOR HIGH PURITY OF SPIRAXIAL® COST OF THE ROOTS



The name is Roots C-100, and for you it means a two-stage *Spiraxial*® compressor that will now deliver oil-free air up to 100 psi. Even more important, this machine will bring down the real cost of compressed air in your operation by lowering equipment, installation and operation expense. Here's how:

LOW, LOW MAINTENANCE—The simple *Spiraxial*® design with intermeshing, screw type rotors provides effective axial flow compression without any mechanical contacts. There are no vanes, valves, rings or other wearing parts in the compression chamber to cause costly maintenance or downtime.

PROCESS PROTECTION—Since no lubrication is required within the cylinder, air or gas is delivered free of contamination. There's no danger to your process . . . no need for oil removal equipment.

HIGH EFFICIENCY—By using the principle of internal compression plus intercooling between stages, the C-100 achieves high efficiency. Through careful design, its performance curve shows peak efficiency when the compressor is operating at design discharge pressure.

SPACE SAVING COMPACTNESS—The C-100 is about half the size and weight of other units for the same service. Packaged piping and intercooler arrangement speeds up installation and lowers costs at the job site.

SMOOTH, STABLE PERFORMANCE—A simple, rotative machine, the C-100 operates practically without vibration and can be installed on a minimum, inexpensive foundation. Special Roots design assures stable, surge-free performance.

THOROUGHLY PROVED—The *Spiraxial* design has demonstrated its complete reliability over the years, in meeting stiff requirements of countless industrial and defense applications.

Developed for chemical processing, agitation, oxidation and other applications requiring 100 lb. air, Roots *Spiraxial* C-100 Compressors are available in seven sizes with capacities from 900 cfm to 3000 cfm. A companion line of *Single Stage* *Spiraxial* units is also available for lower discharge pressure requirements.

Ask your Roots Engineer for details or write to:

ROOTS-CONNERSVILLE BLOWER DIVISION • 900 W. MOUNT ST., CONNERSVILLE, INDIANA
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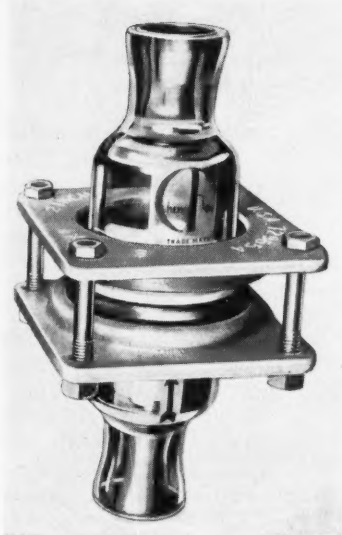
Centrifugal Compressors,
Distillation Apparatus,
Instrumentation

NEW EQUIPMENT . . .

quency response, good positional accuracy, and large thrust.

It consists of a transistorized amplifier with plug-in circuits, an infinite-resolution-type feedback potentiometer, a hydraulic servo-valve and a heavy-duty power cylinder. The last two items are sized to provide the thrust and frequency response to fit the application.

In addition to valve operation, the device can also actuate equipment such as louvers and large butterfly valves, where large loads or unbalanced forces are encountered and where positional stiffness or high-response speed are requisites. — **The Annin Co., Montebello, Calif.** 169A



Check valve

Unit may be mounted vertically or horizontally, for use to 50 psi.

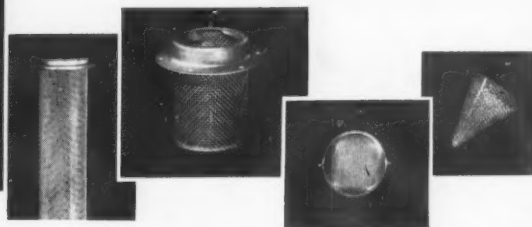
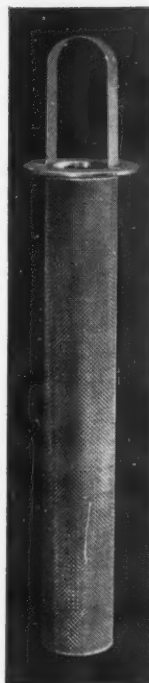
Using Pyrex-brand glass and Teflon construction, this spring-loaded valve features full visibility as well as corrosion resistance to all liquids except hydrofluoric acid and hot concentrated caustics. A Teflon enclosure seals off the stainless steel spring from all gases and liquids.

Model SL200 check valve is available from 1 through 3 in., adaptable to any pipe installation

HOW COMPLEX ARE YOUR FILTERING AND STRAINING PROBLEMS?

Complexity in filtering and straining problems demands woven wire cloth. For this medium favors high, uninterrupted flow . . . is stable and will not creep . . . is versatile and can be fabricated to meet exacting requirements.

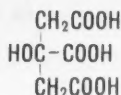
Cleveland Wire Cloth has the experience and facilities to solve your filtering and straining problems. We match your specifications in any metal or alloy . . . in any mesh count and mesh size. Will fabricate single and multi-screen strainers in any shape or size. Write for Bulletin describing woven wire screens for filtering and straining.



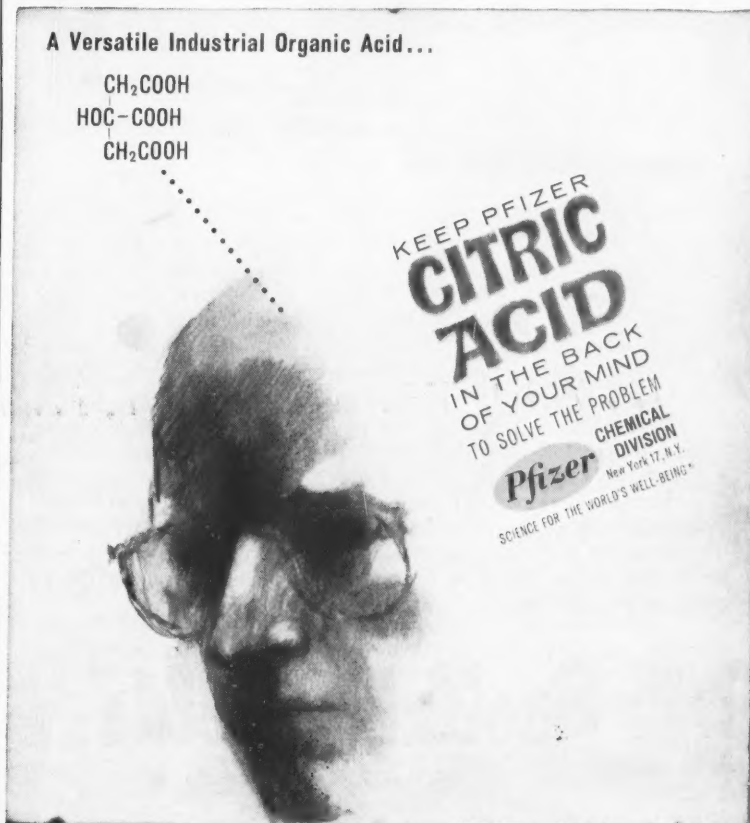
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CITRIC ACID
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FIVE-STAGE EVACTOR AND BOOSTER

NEW TEST CENTER for PROVING and IMPROVING EJECTORS



You are cordially invited to visit this new building devoted entirely to testing, development and research. Here you will see facilities as modern and complete as any existing for the testing of steam jet vacuum equipment.

Floor space and test blocks are sufficient to permit the simultaneous testing of a variety of equipment along with special testing of vacuum processing under actual operating conditions. To assist, we have a steam generating plant equipped with two boilers: one of capacity up to 25,000# per hour at 250# ga; the other, 4,000# per hour at 600# ga. Also: a 60,000-gallon cooling pond and assorted liquid pumps up to 3,000 gpm for both positive pressure and vacuum service; a 4,000 square foot surface condenser; a 6-ton hoist.

Under the same roof for use in research are other types of heavy equipment and laboratory instruments of most accurate design. All together, the facilities of our testing and research center give extra assurance that jet vacuum equipment, fume scrubbers and cooling units from Croll-Reynolds will perform exactly as specified.



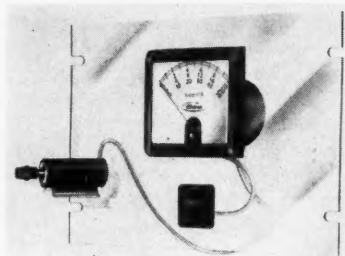
Croll-Reynolds CO., INC.

Main Office: 751 Central Avenue, Westfield, N. J.

Chill-VACTORS® • Steam-Jet EVACTORS® • Aqua-VACTORS® • Fume Scrubbers • Special Jet Apparatus

NEW EQUIPMENT . . .

with a 150-lb. ASA companion flange. A patented lip seal on the seat insures positive sealing at pressures to 50 psi., except for the 3-in. valve, rated at 35 psi. Valves for higher-pressure application are available, using other construction materials.—Chem Flow Corp., Little Falls, N. J. 171A



Tachometer

Multiple-range unit indicates rotation or belt speeds.

A panel-mounted tachometer measures rotation or belt speeds in elevators, conveyors, or other materials-handling equipment. The pickup head can transmit its readings up to 1,000 ft. to the panel indicator, which is calibrated in rpm., ft./min., or in./min.

Available in a multiple-range (47M) or single range (47S) model, the unit has no brushes to wear out, and the single moving part rotates in permanently lubricated, double ball-bearings.—Metron Instrument Co., Littleton, Colo. 172A

Flowmeter calibrator

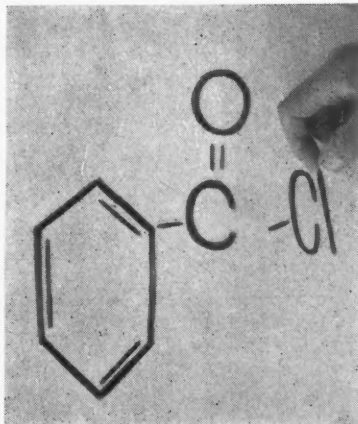
Device is also used in research to measure rate of liquid flow.

Called the Volumetric Flowmeter Calibrator, a device developed by Rocketdyne, a division of North American Aviation, Inc., is said to be more accurate than any other method now in use.

It consists of a pressurized supply tank, test and flow control station, volumetric standpipe and return unit, and a control and recording unit. It is effective over

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Chlorine
Benzoyl chloride
Benzotrifluoride



FAST WAY TO GET A BENZOYL GROUP

Just pull off a chlorine and there you have it.

Our chemical reacts readily. Lets you easily and economically place a benzoyl group in an organic compound—especially through Friedel-Crafts reactions.

It's 99% pure. Clear. Colorless. It freezes at minus 0.9°C. and boils at 197.3°C. It distills from 2% to 97% over a 3.5°C. range.

You can buy it in carboys, nickel drums, or non-returnable lacquer-lined steel drums, as well as tank trucks or tank cars.

For more information on benzoyl chloride's physical properties and also on uses, send the coupon for a data sheet.

ARE YOU UP TO DATE ON BENZOTRIFLUORIDES?

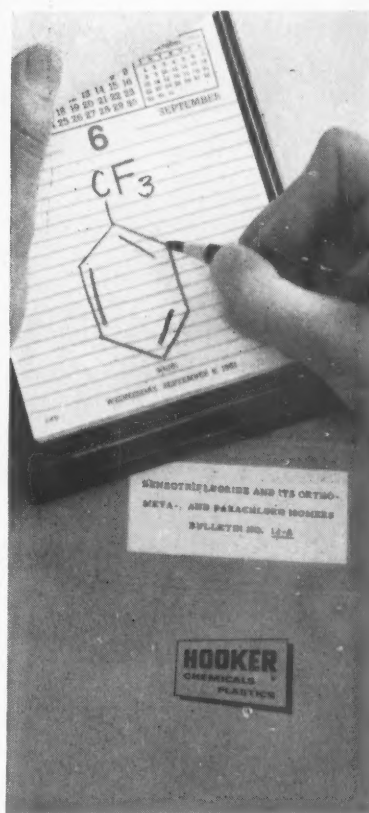
Thumb through the 12 concise pages of our new data file on these chemicals for a quick review of the benzotrifluorides' chemical and physical properties.

Get the latest facts on its *o*-chloro, *m*-chloro, and *p*-chloro isomers.

Learn something new about the score of applications—which range from a lampricide intermediate to pharmaceutical and dye intermediates.

Other useful facts in this free data file are test results for toxicity, and shipping information.

Like a copy? Send us the coupon.



HARD FACTS ON CHLORINE

If you'd like 76 pages of hard, fast facts on chlorine, send the coupon for Hooker Bulletin 125.

It tells a lot about the chemical itself, with charts and graphs on physical properties.

It tells a lot more—about how to handle chlorine safely. Descriptions of equipment and containers should make it easier to run a safe chlorine-handling program.

Finally, there's a listing of the many services you can get from Hooker on chlorine use—services we have developed during more than 58 years of making chlorine.

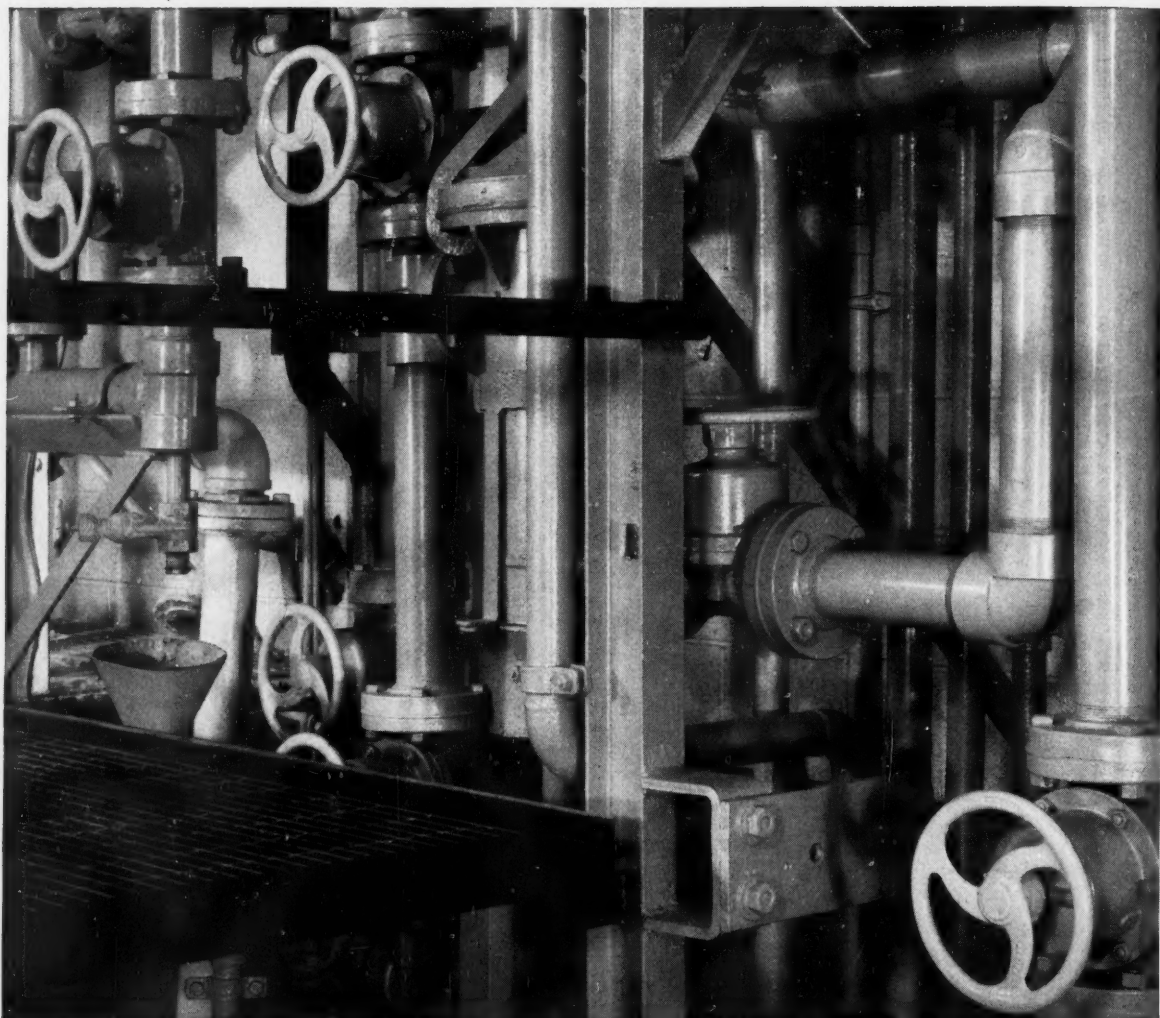
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- ☐ Hooker Bulletin 125 ☐ Benzoyl chloride data sheet
☐ Bulletin 12-A, Benzotrifluoride and its ortho-, meta-, and para-chloro isomers.

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Grinnell-Saunders Straightway Valves* on duty 3 years in pioneer bleach-liquor process.

In world's first continuous, automatic
ORP controlled-reaction $\text{Ca}(\text{OCL})_2$ process . . .

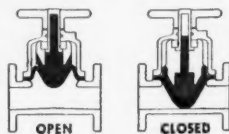
Grinnell-Saunders Diaphragm Valves mark third year of trouble-free service

3 years ago, the world's first continuous, automatic semi-clarified calcium-hypochlorite process — using oxidation-reduction-potential control of reaction — went on stream at Crown Zellerbach's St. Helens, Ore. mill. Selected to control materials-flow in this pioneer installation: Grinnell-Saunders Diaphragm Valves.

Today, Crown Zellerbach reports that the Grinnell-Saunders Diaphragm Valves still give trouble-free service even after 3 years of handling highly-corrosive bleach-liquor!

Grinnell-Saunders Diaphragm Valves offer streamline flow — leak-tight closure — easy maintenance. Working parts are completely isolated from material in the line to prevent corrosion, abrasion, clogging. Wide choice of body, lining and diaphragm materials, too.

See how Grinnell-Saunders Diaphragm Valves can help *your* installation. Write or call Grinnell Co., Providence 1, Rhode Island.



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NEW EQUIPMENT . . .

a wide range of pressures and flow rates of liquids.

Designed originally to aid in testing of high-thrust liquid propellant rocket engines, the device can be used for routine calibration of flowmeters or as a research tool in measurement of liquid flow. —Norlac Engineering & Mfg. Co., Culver City, Calif. 172B



Wet cyclone

Ceramic units, manifolded, operate in parallel to remove small solids.

A compact centrifugal classifier that fits easily into process piping can remove all solid particles larger than a specific size in the 2 to 20 micron range, depending on specific gravities and flows.

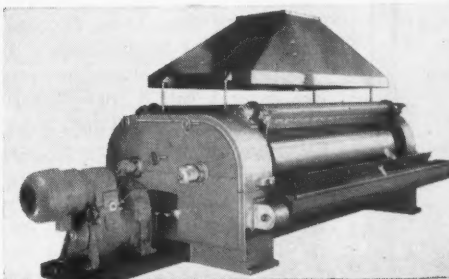
Operating without moving parts, it requires only a pressure differential that frequently is available in the liquid, without additional pumping. Each unit contains 60, 180 or 300 ceramic cyclones manifolded to operate in parallel. Each cyclone clarifies approximately 1 gpm.—Dorr-Oliver Inc., Stamford, Conn. 175A

Vibrating feeder

Natural frequency aids conveying action to reduce power input.

A variable-stroke eccentric on this vibrating feeder provides an infinitely variable rate of feed

"DAVENPORT" ATMOSPHERIC Double Drum DRYER



Model 2-28-60 with several special features for drying a chemical compound. Drums are chrome plated and all other parts coming in contact with vapors or product are fabricated from stainless steel. Variable speed drive provides drum speeds of 1½ to 10 R. P. M.

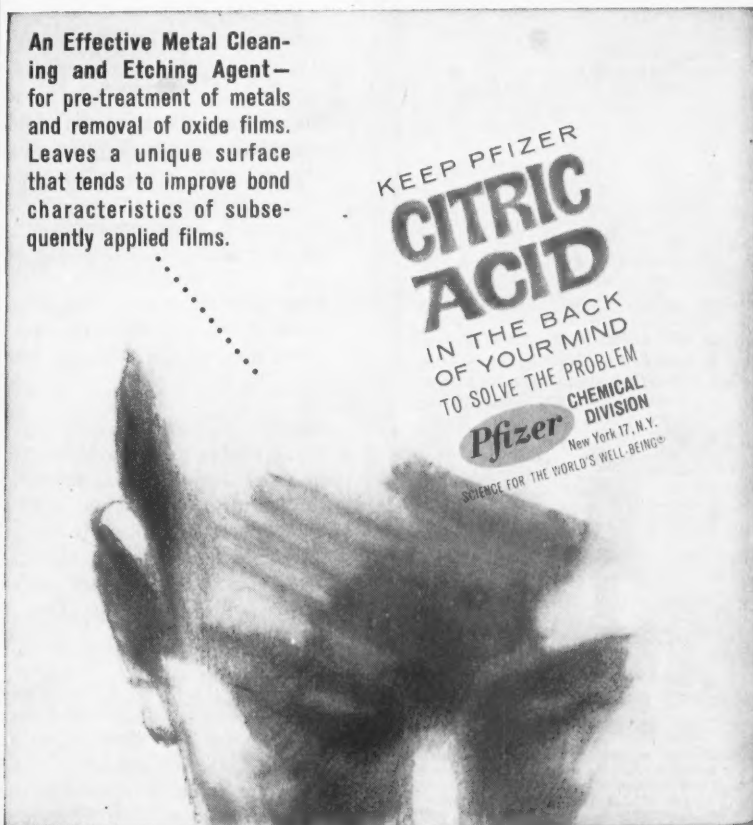
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Division, reports on

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on the new Hayes Type MSX Molecu-Dryer. For your copy, write C. I. Hayes, Inc., 843 Wellington Ave., Cranston 10, Rhode Island.

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(zero to maximum) that can be changed while the feeder is in operation. Material is moved by throwing rather than sliding action to reduce trough wear.

Coil springs vibrate the conveying trough at a predetermined natural frequency. Thus, power is regenerated in the springs to start the next stroke, and little additional power is needed to keep the trough operating, once put in motion by the electric drive motor.

The feeder has a high-amplitude stroke that permits feeding over a wide range of slopes, including uphill. Most bulk material can be conveyed at speeds to 90 ft./min. Frequency of vibration is said to be below the audible range to insure quiet operation.

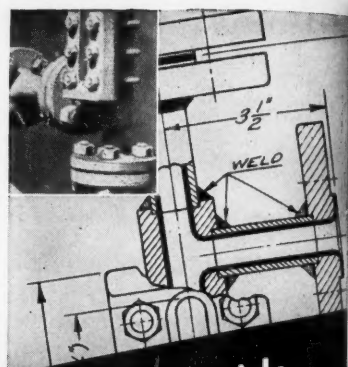
Troughs can be located either above or below the operating unit depending on space and headroom. Either manual or electric remote controls are available.—**Stephens-Adamson Mfg. Co., Aurora, Ill. 175B**

Briefs

Aluminum elbow, with special "humped" design, covers insulation on pipe turns, gives permanent protection against weather and plant atmosphere. Clamped on in 5 min., the ell comes in 13 sizes to fit 109 different combinations of pipe and insulation sizes, from 3 to 12½-in. o.d.—**General Aluminum Supply Co., Kansas City, Mich. 176A**

Manifold valve consists of two block valves and a bypass. Hand-operated, the packless unit has ½-in. tubing connections, comes in Types 303 and 316 stainless steel. Manifold is also available in one, two, four or five-valve styles if desired.—**G. W. Dahl Co., Inc., Bristol, R. I. 176B**

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that is slotted to provide a sturdier bearing face.—Durametallic Corp., Kalamazoo, Mich. 176C

Graph rubber-stamp kit includes three patterns; for 100 blocks per sq. in., 16 blocks per sq. in., and a 3-in.-dia. circle for polar coordinates. Stamps are used to present graph material in notebooks, reports and correspondence, where small graphs are adequate and regular graph paper would be bulky.—Edmund Scientific Co., Barrington, N. J. 177A

Explosionproof d.c. motor, fully submersible and radio shielded, comes in ratings of 1/20 to 3 hp., in a voltage range of 6 to 230. Designed for continuous or intermittent duty.—Piqua Machine & Mfg. Co., Piqua, Ohio. 177B

Disposable PVC glove is only 0.006-in. thick, enables wearer to feel items he is handling almost as if barehanded. Prepounded for easy donning, the glove has a tensile strength of 1,000 psi. Cost is about 7¢ each.—Wilson Rubber Co., Canton, Ohio. 177C

Equipment Cost Indexes . . .

	Mar. 1961	June 1961
Industry		
Avg. of all	237.2	236.9
Process Industries		
Cement mfg.	231.3	230.9
Chemical	238.0	237.3
Clay products	224.8	224.4
Glass mfg.	224.7	224.0
Paint mfg.	229.7	229.4
Paper mfg.	229.3	228.6
Petroleum ind.	234.7	234.8
Rubber ind.	237.6	237.6
Process ind. avg.	235.9	235.2

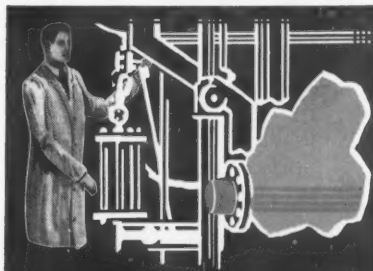
Related Industries

Elec. Power equip.	237.9	235.1
Mining, milling	239.4	238.7
Refrigerating	268.5	268.6
Steam power	224.9	225.0

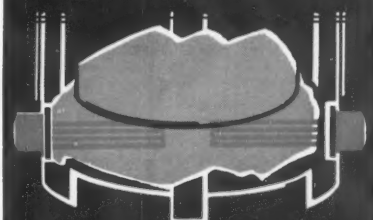
Compiled quarterly by Marshall and Stevens, Los Angeles, for 47 different industries. See Chem. Eng., Nov. 1947, pp. 124-6 for method of obtaining index numbers; Mar. 6, 1961, pp. 115-116 for annual averages since 1913.

CHROMALOX Flange-Type, Electric IMMERSION HEATERS

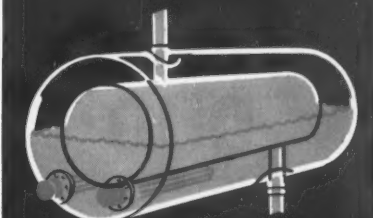
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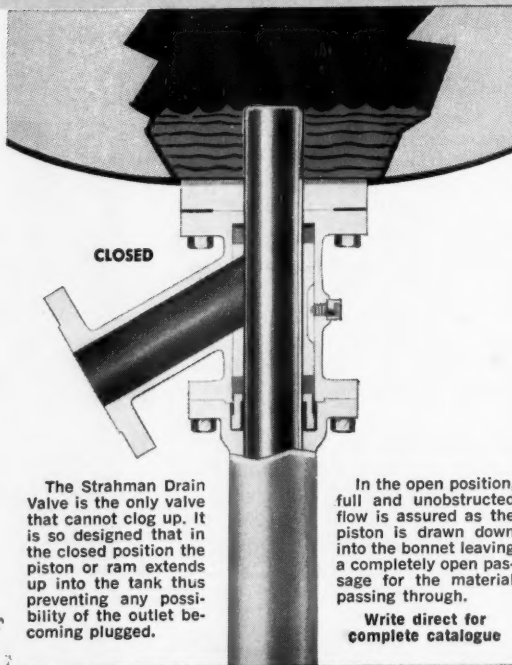
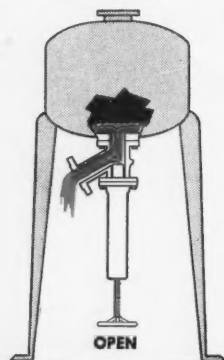
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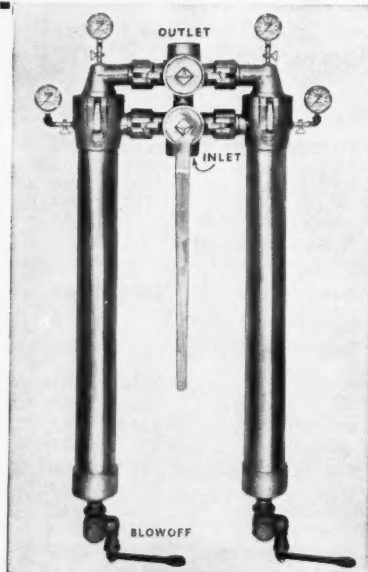
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Technical Bookshelf

CATALYSIS TRANSLATED

SOVIET RESEARCH IN CATALYSIS, 1956. 6 VOLS., PAPERBACK. CONSULTANTS BUREAU, 227 WEST 17TH ST., NEW YORK 11, N. Y. \$120.

Reviewed by M. Boudart, Associate Professor of Chemical Engineering, Princeton University.

This is caviar: it is expensive and should be treated only as an appetizer. The articles form a representative selection, by Prof. Thomas J. Gray of Alfred University, of Soviet papers on contact catalysis. The translations are generally good if we concede that no one should have a great deal of trouble in guessing that a "suspended layer" is actually a fluidized bed. The only major criticism of this undertaking is the lack of an index or some sort of cumulative table of contents.

A chemical engineer will find only a handful of papers, all in Vol. I, dealing with his traditional topics—heat and mass transfer. Yet, catalysis is a subject of immediate applied interest, and the many engineers deeply immersed in catalytic matters will find these translations very useful. So useful in fact that they might well decide to follow the Soviet literature, either in translation, with the usual delays, or in the original.

The Soviets are very active in catalysis, and many of their theoretical contributions are excellent and quite stimulating. Those of us in the field who cannot afford to learn Russian are well advised to buy these translations despite their high cost.

THEORY AND PRACTICE

TREATISE ON ANALYTICAL CHEMISTRY. PART I: THEORY AND PRACTICE. VOL. 2, PAGES 811 TO 1,308. ED. BY I. M. KOLTHOFF AND P. J. ELVING, ASSISTED BY E. B. SANDELL. INTERSCIENCE. \$16.

Reviewed by J. M. Durham, Sterling-Winthrop Research Institute, Rensselaer, N. Y.

Part of a major work projected to include over a score of volumes, this is the second volume on the

theory and practice of analytical chemistry. Part II will deal with the analytical chemistry of the elements while Part III will be devoted to the analysis of industrial products.

Written by fourteen authors, the present eleven chapters include two on reactive groups as reagents applied to organic and inorganic systems. The remaining nine are on the principles and techniques of separations. Additional material on separations will be in the next publication.

Separations in this volume are discussed under the following chapter headings: Principles of Separations; The Phase Rule in Analytical Chemistry; Decomposition and Dissolution of Samples—Inorganic; Decomposition and Dissolution of Samples—Organic; Mechanical Methods; Diffusion Methods; Electromigration and Electrophoresis; Distillation; Vacuum Methods.

If two chapters may be singled out, that on dissolving inorganic samples contains the wisdom gained by University of Michigan's Professor Hobart Willard through sixty years as an analytical chemist. That on diffusion methods contains a praiseworthy 34-page discussion on thermal diffusion, a technique deserving a wider following.

Throughout, the physical-chemical basis underlying each topic is stressed. This will prove of particular value to the chemical engineer who desires rapid orientation with respect to a specific topic. As Professor Lockhart Rogers of M. I. T. points out, one of the most influential factors in the choice of a separation procedure is the investigator's familiarity with the technique.

LIMITED VALUE

ENGINEERING MANAGEMENT. 2ND ED. BY S. A. ROBERTSON. PHILOSOPHICAL LIBRARY. 467 PAGES. \$10.

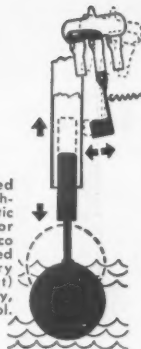
Reviewed by F. P. LaBelle, Director of Engineering, Inorganic Chemicals Div., Monsanto Chemical Co.

In his preface, Professor Robertson indicates that the book is for engineers studying for the "Industrial Administration" examination of the British Institution of Mechanical Engineers. The work is exactly

permanent magnetic force...



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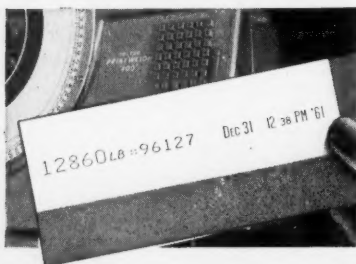


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BOOKSHELF . . .

that—a broad summary of the components of industrial engineering, tailored to mechanical production situations and English laws.

Part one, *The Art of Management*, emphasizes that management is not an exact subject, and approaches the worker-manager relationship in a highly idealistic fashion. The author's idea of contract "integration" rather than bargaining would receive little support from any manager experienced in negotiating with an aggressive unionist.

The Science of Management, part two, details the areas where the author feels that information is available to managers with some degree of scientific or organized status, i.e., in law, economics, psychology, physiology, etc.

In the third part of the book (and accounting for two-thirds of its length) the *Practice of Management* is detailed. This is the "how to do it" outline, covering in brief, factual, but not thought-provoking, fashion everything from market research to ways of forming a business, materials and equipment, and accounting and control mechanisms. This section is heavily laced with English legislation references and draws extensively on the *Encyclopaedia Britannica* as a primary information source. It is the major area updated in the 1961 edition.

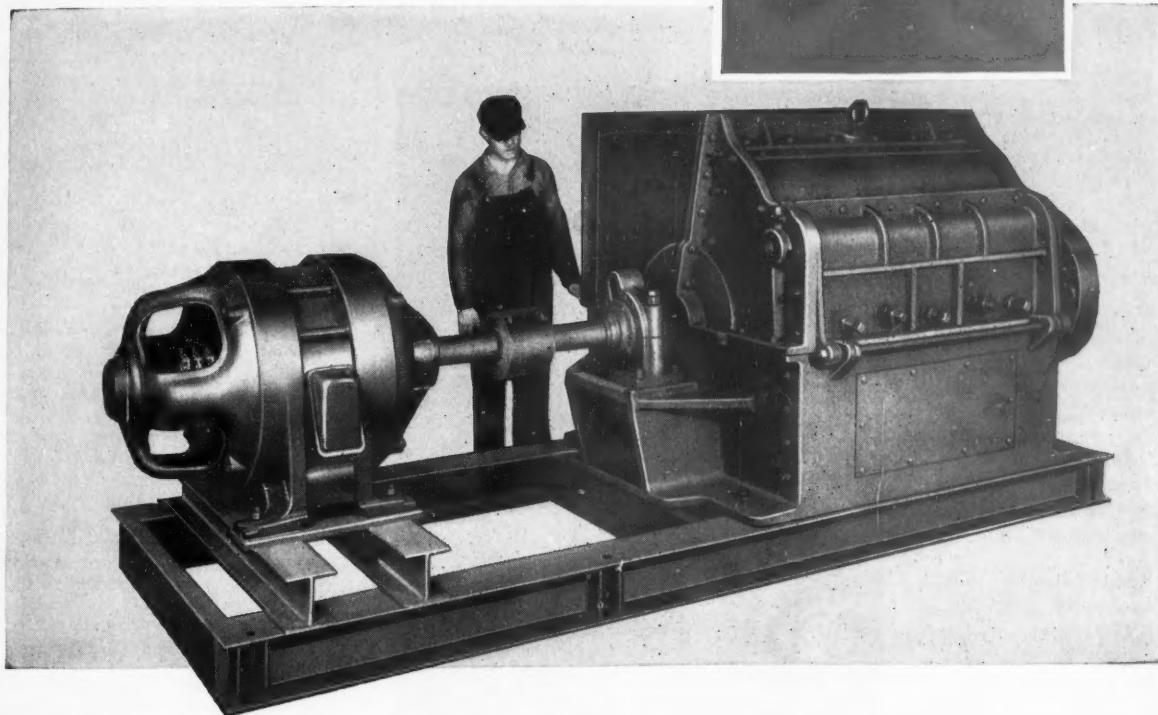
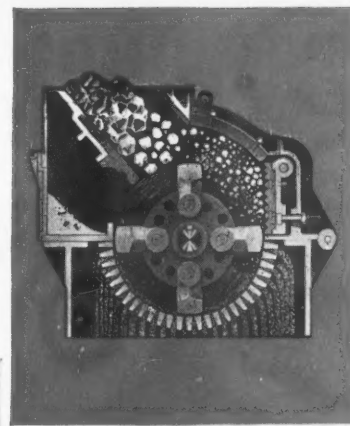
Although an occasional reader might find the broad, simplified textbook approach to industrial engineering a helpful reference source, most chemical engineers will find it of limited value.

In Rapid Review

Pyridine and Its Derivatives. Part 2. Ed. by E. Klingsberg. Interscience. 576 pages. \$37.50. Part 2 of this series exhaustively reviews the chemistry of pyridine quaternaries, N-oxides, alkyl, aryl, halo, metallo and nitro derivatives and reduction products of the nitro pyridines. Emphasis is on synthetic methods, structure and reaction mechanisms. Little mention is made of medicinal or other uses.

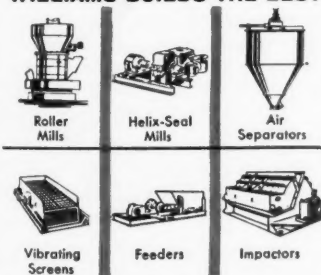
Elements of Nuclear Engineering. By G. Murphy. Wiley. 213 pages. \$7.50. Written for senior engineering students, to give them an over-all view of the field of nuclear engineering, this is an excellent introductory text for

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Organo-Metallic Compounds. 2nd ed. By G. E. Coates. Wiley. 366 pages. \$7.50. Excluding the borderline elements—silicon, phosphorus, arsenic—this second edition reviews all types of organo-metallic compounds, including borazines and π - and σ -complexes of the transition elements. Particular emphasis is directed to preparative methods. Although certain recent advances such as the Wittig Reaction and benzyne intermediates are included, most of the chemistry of organo-alkali compounds has been omitted. Coverage of the remaining groups is more comprehensive, however, and presents an excellent review of an important and rapidly expanding phase of chemistry.

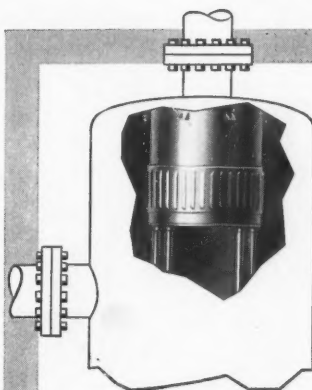
Glass Fibre Reinforced Plastics. Ed. by A. De Dani. Interscience. 296 pages. \$9.75. Roughly one-third of this introductory text, authored in Britain, deals with raw materials, identifying a wide selection of resins and glass fibers as to properties, handling and processing techniques, applications. Weighted more heavily for the workshop manager than the technical staff, the rest of the book is devoted to molding methods, finishing operations and equipment. Also included is a 24-page section of black and white plates and numerous line drawings and tables.

Handbook of Chemistry. 10th ed. Ed. by N. A. Lange. McGraw-Hill. 1,969 pages. \$11. All dressed up in spanking new attire (larger type, complete new layout), Lange appears once more—virtually a library in himself—for his latest round-the-world tour of university, laboratory and industry. For the tenth time in a generation, the Handbook has collected every conceivable tidbit of the latest data on 6,500 organics, reams of inorganics, elements, refractories, ores, etc., ad infinitum. Newest entry: properties of plastics as construction materials. Index alone covers 27 tissue-thin pages, has more than 3,000 listings. As his fans have known since 1934, Lange has no business in your library. He belongs on your desk.

The Chemistry of the Terpenes. By A. R. Pinder. Wiley. 223 pages. \$8.25. Presented as a source of information that is intermediate between the general textbooks and the more comprehensive works on the subject, this book can serve as a helpful guide to those interested in this specialized field. Broad coverage is given to the monosessqui-, and diterpenes. The material on the isolation of terpenes, the more-

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complex terpenes and the two short chapters dealing with rubber and the biogenesis of terpenes is presented in a sketchy manner but the author matches this shortcoming by providing valuable bibliographies of the leading references and more-comprehensive reviews on these subjects.

Physical Chemistry. 2nd ed. By F. Daniels and R. A. Alberty. Wiley. 744 pages. \$8.75. Designed as a text for a first undergraduate course in physical chemistry, this book is in reality the tenth edition of "Outlines of Theoretical Chemistry," written by Frederick H. Getman in 1913. This "second edition" has been completely rewritten and substantially expanded. Very readable, it offers a greater use of mathematics and an increased number of problems, many of which are accompanied by answers.

More New Books

Exploring Mathematics on Your Own. By W. H. Glenn and D. A. Johnson. Doubleday. 303 pages. \$4.50.

ASM Review of Metal Literature—1960. Ed. by M. R. Hyslop. American Soc. for Metals, Novelty, Ohio. 1,421 pages. \$25.

Fuel Element Fabrication. Vol. 1. By various authors. Academic Press. 538 pages. \$14.

Black Gold—The Story of an Oil Pioneer. By A. Beeby-Thompson. Doubleday. 544 pages. \$5.95.

Management's Talent Search—Recruiting Professional Personnel. By P. W. Maloney. American Management Assn., 1515 Broadway, N. Y. 36, N. Y. 160 pages. \$4.50 (\$3 to AMA members).

Progress in Very High Pressure Research. Ed. by F. P. Bundy, W. R. Hibbard, Jr., and H. M. Strong. Wiley. 314 pages. \$12.

Response of Metals to High Velocity Deformation. Ed. by P. G. Shewmon and V. F. Zackay. Interscience. 491 pages. \$18.

Flow of Fluids Through Porous Materials. By R. E. Collins. Reinhold. 270 pages. \$12.50.

Plastics Nuclear Engineering. By J. O. Turner. Reinhold. 139 pages. \$5.50.

Fatty Acids. Part 2. 2nd ed. Ed. by K. S. Markley. Interscience. Pages 715-1,485. \$27.50.

Thermoelectricity: Science and Engineering. By R. R. Heikes and R. W. Ure, Jr. Interscience. 576 pages. \$18.50.

Physical Chemistry. By G. M. Barrow. McGraw-Hill. 694 pages. \$8.95.

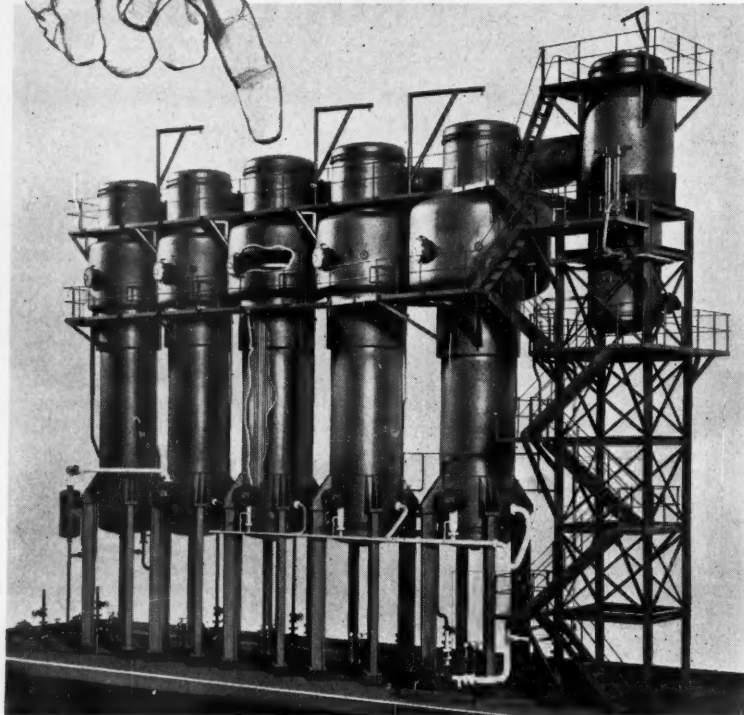
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FREE: Technical bulletin on cleaning and maintenance of Long Tube Vertical Evaporators. Written by Swenson engineers to provide information you can use. Write for your copy to: Swenson Evaporator Company, 15669 Lathrop Ave., Harvey, Illinois. In Canada: Whiting Corporation (Canada) Ltd., 350 Alexander Street, Welland, Ontario, Canada.

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PRO & CON . . .

Continued from page 7

developments, 2,2,4-trimethyl-1,3-pentanediol monoisobutyrate, or Texanol for short.

While we are quite enthusiastic about the potential market for this unusual ester/alcohol, we do not believe it can ever be realized at the 70¢/lb. price noted in your story. Actually, this should have been 17¢/lb., which, you will no doubt agree, makes this a much more likely commercial prospect.

ROBERT R. MOORE

Eastman Chemical Products, Inc.
New York, N. Y.

► *Sorry. This error was due to a typographical mistake in the news release.—ED.*

Helps With the Homework

Sir:

In your June 26 Pro & Con (p. 7), Mr. Lapidot expressed surprise that you found a place for "Simple Method Proves Multiplication."

I was surprised too, but for a different reason. My third grade teacher's method of providing multiplication involved dividing the product by one of the multipliers—a method in most cases more tedious than the original problem.

I snatched onto this gem of knowledge, recognizing it as a definite time-saver for those of us who missed it in the third grade. I've passed it on to countless technical and nontechnical people and found few who had ever heard of it. I have received nothing but heartfelt thanks along the line.

It isn't so much that we have to check our own multiplications, but our children ask us to check their multiplication homework.

EDWARD J. OTTERSON

Wisconsin State Board of Health
Madison, Wis.

Your comments and opinions are important. Send them to Editor, Chemical Engineering, 330 West 42nd St., New York 36, N. Y.

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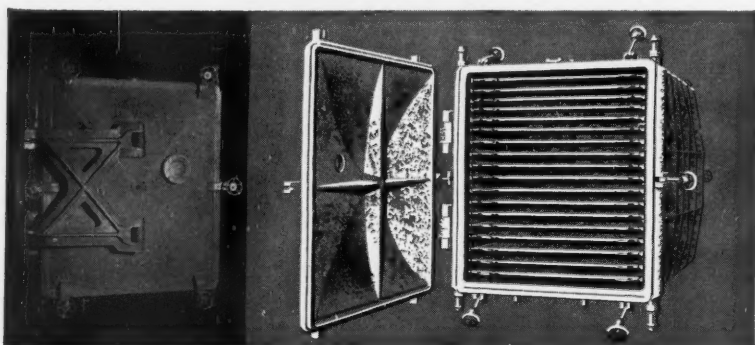
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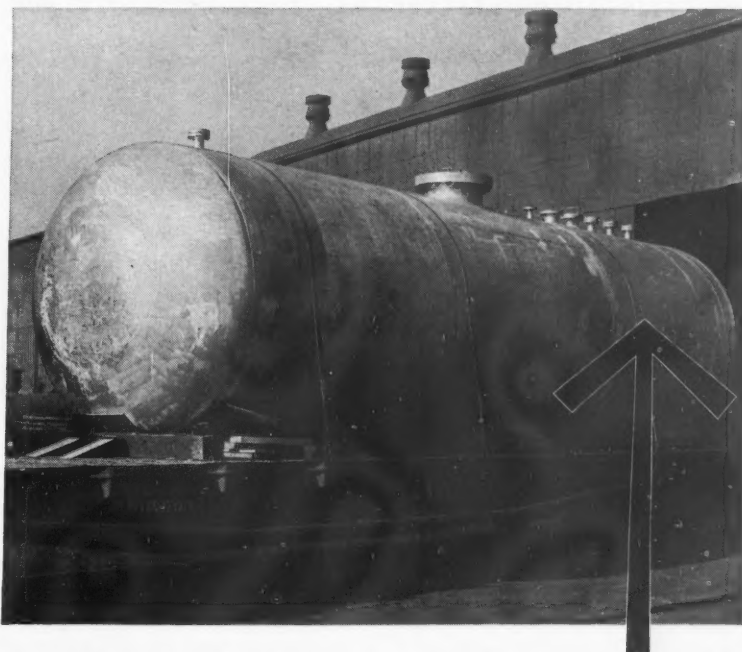
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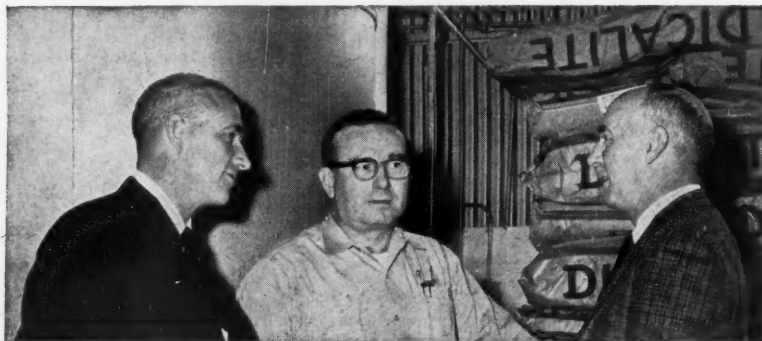
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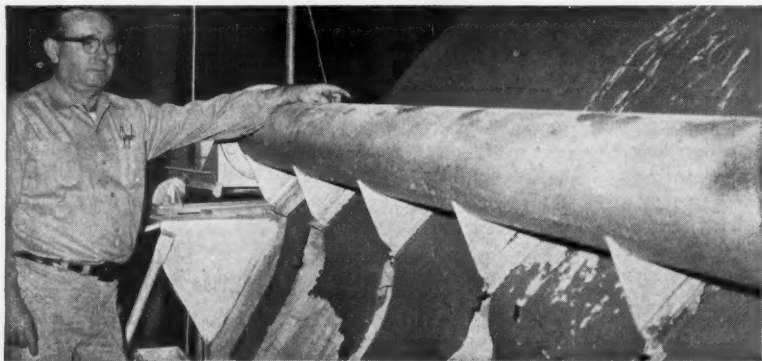
Marty Harris, Dicalite engineer, reviews filtration procedure with A. H. Buck, plant manager, and R. C. Mosher, president of Barnett Laboratories.

The food additive carotene is widely used in margarine, shortening, bakery goods and pharmaceuticals where a natural yellow color and a high potency of vitamin A is desirable. A unique processing step, which might be called filtration in reverse, is employed by a leading producer of carotene—Barnett Laboratories, of Long Beach, California. Here, the liquid filtrate goes into cattle feed—and the valuable carotene is extracted from the filtered-out solids.

Barnett grows their own carrots . . . a special variety yielding at least twice as much carotene as the ordinary table variety, and taking twice as long to grow. After the carrots are crushed, the carotene is washed

out and the liquid goes to filtration. A Dorr-Oliver rotary vacuum precoat filter is used, starting with an inch-and-a-half precoat of Dicalite Special Speedflow Filteraid. The knife is set for a minimum cut to remove the deposited carotene material with the least possible amount of filteraid. This material is flash dried and air conveyed to the final steps of solvent extraction and crystallization.

Dicalite, while helping Barnett work out their filtration problems, was also able to assist them in designing the flash drying air conveyor system. Careful consideration of the total process is typical of Dicalite service. We'd be glad to work with you.



The solid crude carotene coming off the knife is the object of Barnett's filtration.

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Dicalite's "Man on the Spot"

M. B. Harris

When Marty Harris first consulted with Barnett, they were not satisfied with their filter operation. His first step was to take samples of the carotene liquid to the Dicalite products laboratory for study. Then a series of tests was made on a miniature rotary precoat filter. Harris worked closely with a Barnett representative and the Dicalite research men on this project. His recommendations to Barnett resulted in marked improvement in filtering efficiency. Today, after continued study and improvements worked out with Barnett, the firm is getting more than double the production per hour from the same filter.

Harris graduated from the University of Idaho with a Ch.E. degree, and worked for some time with American Potash & Chemical Corporation. For the first 2 years after joining Dicalite in 1945 he worked in the laboratory on research and customer service, before going into the field as District Manager, first in San Francisco and then in Philadelphia. He now serves Dicalite customers throughout the Southwest.

Marty is entitled to add P.E. after his name, for he holds a California State license as a Professional Chemical Engineer. He has contributed articles on filtration to publications in the petroleum, sugar and swimming pool fields, and is a member of the American Chemical Society, AIChE, Master Brewers Association of America, the American Institute of Sugar Beet Technologists and the Papermakers and Associates of Southern California.

TECHNICAL LITERATURE

on Dicalite Filteraids is available on request. Bulletin B-14 discusses the principles and operating practices of filteraid filtration, and its applications in many industries.

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Silicone fluids.....versatile additive designed to improve characteristics of many products. Write for further information.

L125 *General Electric Company

Solvent.....New improved Varsol offers long-lasting freshness. Retains its efficient solvency even after long storage or many processings in your plant. Information.

145 *Humble Oil & Refining Co.

Solvents.....New technical bulletins are available on Pent-Oxone and Pent-Oxol solvents. Bul. A deals with physical properties & Bul. B deals with use in acrylic lacquers.

56 *Shell Chemical Co.

Trimethylolpropane......used in the manufacture of polyurethane foams and alkyd paints. Imparts heat resistance and toughness. Technical data offered.

37-38a *Celanese Chemical Co.

Construction Materials

Aluminum......Literature is available giving information on the cryogenic applications of Alcoa Aluminum and may be had upon request.

193c *Aluminum Co. of America

Aluminum......A booklet entitled, "Process Industries Applications of Alcoa Aluminum" is available for information on the wide variety of applications of aluminum.

191d *Aluminum Co. of America

Aluminum Alloys......A booklet giving information on resistance of aluminum alloys to weathering & to chemically contaminated atmospheres is available.

1956 *Aluminum Co. of America

Construction Material......Koroseal PVC won't corrode, can't rust, is easy to fabricate and install. A catalog is available describing its many advantages.

1 *B. F. Goodrich

Extension Cable......Available with from 4 to 48 pairs of solid-conductor temperature-compensated wires. Custom & standard constructions.

Cat. G100-2.
L205 Minneapolis-Honeywell

Gaskets......Spiral-Wound gaskets for critical sealing applications using the proper metal, filler & yield characteristics for the specific job.

69 *Flexitallic Gasket Co.

Packings......Two booklets, "Packings for Valves and Pumps" and "Designing with Teflon" are available for information on packings made with Teflon.

41 *E. I. DuPont de Nemours

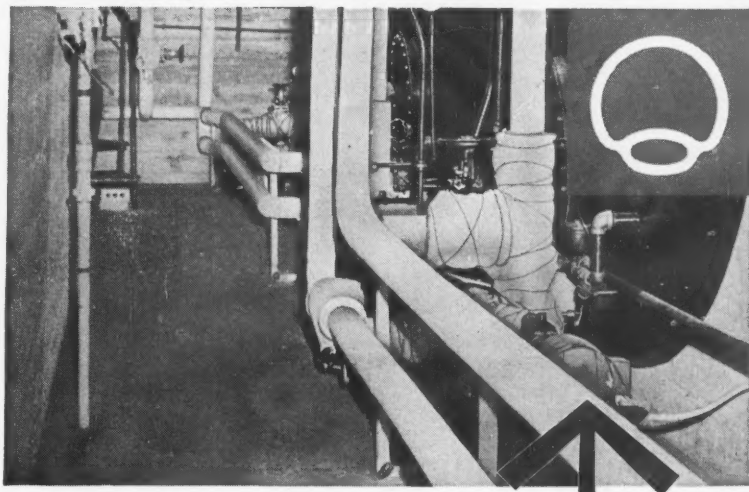
Packings......New 5881 lattice braid packings resist strong acids at temperatures from 90 deg. F. to 500 deg. F. Information is contained in Catalog AD-185.

44 *Garlock, Inc.

*From advertisement, this issue

from ALCOA

good designs made better with aluminum



Globe Engineering installed Alcoa Unitrace system for piping paraffin and stearic acid . . . lowered fire hazard, increased production rate

Binney & Smith Inc., Winfield, Kansas, CRAYOLA® crayon manufacturer, recently effected cost savings with Alcoa* Unitrace piping, at one-eighth the quoted cost of stainless. Formerly, block paraffin had been melted slowly in holding pots. Now, Binney & Smith buys paraffin by tank carload, heats and pumps directly to underground storage. Stearic acid is also handled in the same system without discoloration. Fabricated and installed by Globe Engineering Co., Wichita, Kansas, the Unitrace system effected savings in purchasing, insurance, handling and production. Alcoa Unitrace is the light, strong, corrosion-resistant pipe that provides steam and product passages in a single extruded unit—eliminating costly external steam jackets or inefficient tracer tubes. Please send coupon for more information.

*Registered trademark of Aluminum Company of America



Aluminum Company of America, 825-HH Alcoa Building, Pittsburgh 19, Pa.

Please send me the following literature covering Alcoa Aluminum for tubular products and other uses in the process industries.

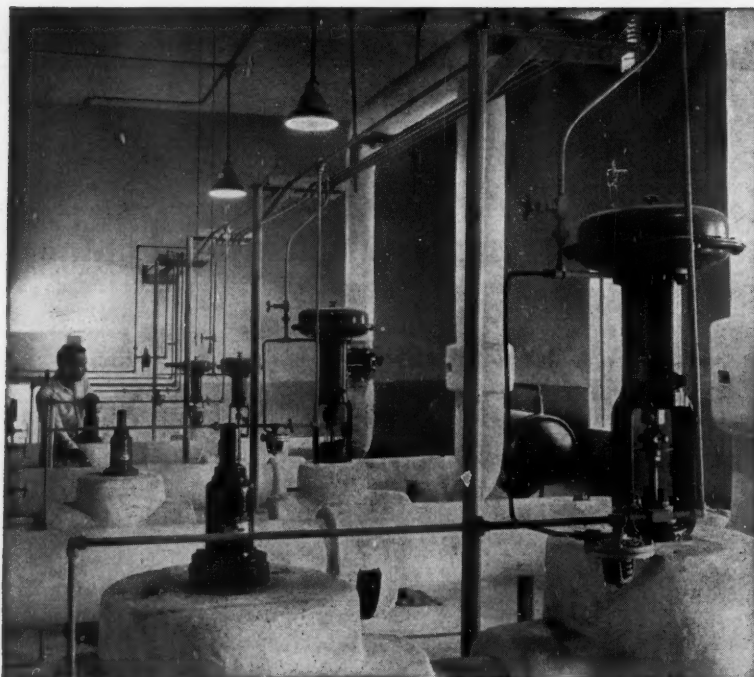
- ☐ 34-10197 Aluminum Pipe and Fittings
- ☐ 34-10418 Alcoa Unitrace: Combines Piping and Tracing in One Unit
- ☐ DD- 514 Alcoa Duotrace Technical Report
- ☐ 68-10460 Process Industries Applications of Alcoa Aluminum

Name _____ Title _____

Company _____

Address _____

City _____ Zone _____ State _____



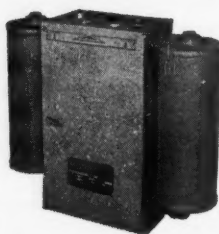
Air-operated valves in Curry Hollow Station.

Lectrodryer eliminates moisture... ends weekly valve maintenance at Carnegie Gas Blending Station

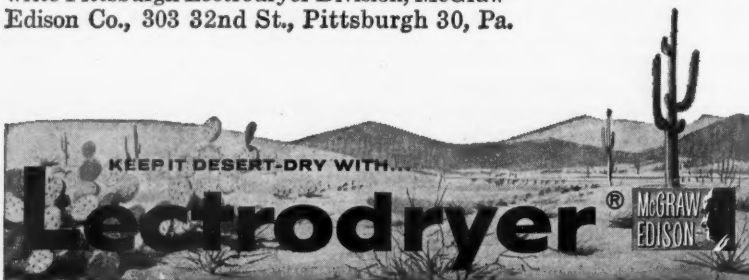
Carnegie Natural Gas Company blends gas from company-owned fields with air to supplement artificial gas produced at the Clairton By-Product Coke Works... then pipes the mixture to all U. S. Steel plants along the Monongahela River. Control of the mixing is handled by valves actuated by compressed air, which is kept desert-dry with a Budget Lectrodryer.

Prior to installation of this dryer, valves had to be drained of water every week. But now, bleeding the air lines—a time-consuming operation—has been completely eliminated. Valves function perfectly.

Budget Lectrodryers are inexpensive insurance (cost only \$480 F.O.B. Pittsburgh) against damaging moisture; ideal for any installation requiring small quantities of dry air. For data sheets citing solutions to moisture problems, write Pittsburgh Lectrodryer Division, McGraw-Edison Co., 303 32nd St., Pittsburgh 30, Pa.



Budget Lectrodryer unit is portable, easy to install.



LITERATURE . . .

- Packing Sets.**.....New low gland pressure TFE Teflon packing sets used for valves, heat exchangers and other static & semi-static applications. Bulletin CP-552. 43 *Chemical & Power Products
- Protective Coating.**.....Tygon airless vinyl cuts painting costs 30% to 50%. Meets every requirement for airless spray application. Details in Technical Data Sheet AV. 54 *U. S. Stoneware
- Refractory, Silicon Carbide.**.....Crystolon "63" has high thermal conductivity, excellent heat shock and wear resistance, and good resistance to most corrosive liquids. Information. 89 *Norton Co., Refractories Div.
- Wire Cloth.**.....Manufactured to your specifications. A full range of wire cloth from any metal or alloy. Complete information in Bulletin 160. TR171 *Cleveland Wire Cloth & Mfg.
- Zinc Dust.**.....is now being used as a reducing agent, precipitating agent, purifier, catalyst, polymerizing agent, & in rust-resistant paints, bleaches, etc. Information. 155 *American Smelting & Refining

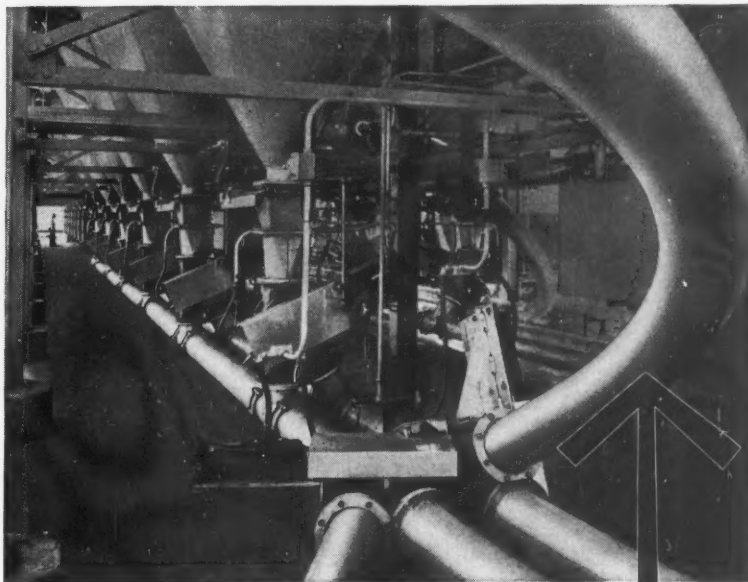
Electrical & Mechanical

- Automatic Transfer Switches.**.....Designed to transfer powerload to standby supply when normal power fails or drops too low. Bulletin 1270 gives details. 159c *Allen-Bradley Co.
- Conveyor Pulleys.**.....Technical data available on these taper-lock steel conveyor pulleys. Maximum strength with minimum amount of weight. 161b *Dodge Manufacturing Corp.
- Coupling.**.....Para-Flex couplings feature a modern, tire-like flexing element that handles angular and parallel misalignment & absorbs torsional vibration. Bulletin. 160 *Dodge Mfg. Corp.
- Couplings.**.....for every operation that calls for quick, tight connections. Available in brass, malleable, stainless, aluminum, etc. Details in illustrated Catalog C-11. 67 *Ever-Tite Coupling Co., Inc.
- Enclosed Starters.**.....Spin Top enclosed starters are now available wired & mounted on racks built to your specifications. Details are available on request. 81 *Square D Company
- Float Switches.**.....Available in a wide range of types for automatic control of motors operating tank or sump pumps. Write for Bulletin 840. 159b *Allen-Bradley Co.
- Foot Switches.**.....Built to withstand the most severe industrial usage, assures complete "safety" for the operator. Bulletin 805 gives details. 159f *Allen-Bradley Co.
- Gear-Driven Swivel Joints.**.....are available in 2, 2½, 3 and 4 inch sizes. There is a size and type to meet every requirement. Full catalog and price information. 27 *Continental-Emsco Co.

* From advertisement, this issue

from ALCOA

good designs made better with aluminum



Aluminum eliminates contamination, withstands low temperatures without embrittlement in southwestern polypropylene plant

To prevent product discoloration, this polypropylene process employs ALCOA® Aluminum—in piping, bins, hoppers and vessels. Also, aluminum's excellent low-temperature durability is an important asset; tensile and yield strengths actually increase without embrittlement as operating temperatures drop.

Aluminum is nontoxic, has a higher strength-weight ratio than most metals, costs less to install than any other suitable material. We'd like to send you more information. Please send the coupon.



Aluminum Company of America, 825-V Alcoa Building, Pittsburgh 19, Pa.

Please send me the following literature covering Alcoa Aluminum for tubular products and other uses in the process industries.

- ☐ 34-10197 Aluminum Pipe and Fittings
- ☐ 34-10418 Alcoa Unitrace: Combines Piping and Tracing in One Unit
- ☐ 88-11251 Cryogenic Applications of Alcoa Aluminum
- ☐ 68-10460 Process Industries Applications of Alcoa Aluminum

Name _____ Title _____
 Company _____
 Address _____
 City _____ Zone _____ State _____

Motors.....Models range from ¼ hp to 100hp. A color brochure, Bulletin F-1797 contains information on Varidrive motors and is available on request.
 219 *U. S. Electrical Motors, Inc.

Motors.....Guardistor motors are engineered to give top performance in a wide range of applications. Additional information is contained in booklet B-7876-A.
 8-9 *Westinghouse Electric Corp.

Multi-Speed Drum Switches.....Designed for manual starting, speed changing and reversing of polyphase multi-speed motors. Write for Bulletin 365.
 1591 *Allen-Bradley Co.

Pillow Blocks.....Ball bearing pillow blocks with normal duty shaft sizes ½" to 2-½" and medium duty shaft sizes 1-½" to 3-½". Fully self-aligning. Tech. Bul.
 161a *Dodge Mfg. Corp.

Rolling Bearings.....Further information available on these rolling bearings. Information includes ratings as well as other pertinent data.
 161d *Dodge Manufacturing Corp.

Rotating Cam Limit Switches.....Heavy-duty controls for use on automatic production machines. For more information, write for Bulletin 803.
 159h *Allen-Bradley Co.

Rupture Discs.....are available in sizes ranging from ¼" to 44" in diameter, covering rupture pressures from 3 to 100,000 PSI. Information on request.
 162 *Black, Sivalls & Bryson, Inc.

Steam Turbine-Generator.....Complete information on types and ratings from 2000 kw to the largest is contained in Bulletins 7654A & 9448 which are offered.
 14-15d *Allis-Chalmers

Take-ups.....A complete range available of stock models, sizes. Information on roller, ball, babbitted available on request. Also other pertinent details.
 161e *Dodge Manufacturing Corp.

Handling & Packaging

Conveying Systems.....Pneumatic conveying systems increase production, cut contamination. For handling dry, bulk or granular materials. Information.
 98 *Fuller Company

Gas Transports.....Extreme mobility & economical storage make Taylor-Wharton gas transports ideal for bulk transportation of compressed gases. Information.
 30 *Harrisburg Steel Co.

Hoisttractor.....in combination with air hoist teams two-way power to save time and reduce fatigue. Designed for maximum safety. Section 86 and 87 bulletins.
 94 *Gardner Denver Company

Idler.....New 44-page Idler bulletin describes the more than 800 units available in the complete line. Covers all features. Copy will be sent on request.
 31 *Barber-Greene

* From advertisement, this issue



USED TO THINK EVERY
STEAM TRAP LEAKED STEAM.



THEN I FOUND ONE THAT DIDN'T,
BUT IT WOULDN'T VENT AIR.



FOUND ONE THAT VENTED AIR, BUT
IT NEEDED A COOLING LEG.



DISCOVERED A TRAP THAT
REMOVED CONDENSATE AT STEAM TEMP,
-MAINTENANCE WAS TOO HIGH.



THEN I FOUND A LOW MAINTENANCE
TRAP. IT DIDN'T WORK
AGAINST BACK PRESSURE.



AT LAST I FOUND ONE THAT WORKED
AGAINST BACK PRESSURE, BUT IT'S
CAPACITY RATING WASN'T DEFENDABLE.



ARMSTRONG PROMISES TRUE CAPACITIES
AND EVERYTHING ELSE, SO I CALLED THEM.
THEY TOLD ME TO RELAX. I COULDN'T.



THEY TOLD ME ABOUT
ARMSTRONG'S GUARANTEE.
WHAT'S I HAVE TO LOSE, I TRIED THEM.



EFFICIENCY IS UP, FUEL BILLS ARE DOWN,
SO ARE MAINTENANCE COSTS.
MAN I'M LIVING!

No one trap can do *everything* better than every other trap. Some traps vent air better than others, some remove condensate faster, etc. But, there is no one trap *best* in every phase of trapping. Armstrong has been manufacturing the Inverted Bucket Trap for nearly fifty years, and though the traps have changed with the requirements of the times, the Inverted Bucket principle has remained. For on overall trap performance, year-in and year-out, nothing beats the Armstrong Inverted Bucket Trap. It's a rugged well-built trap

that does *more* things better than any other trap. It's guaranteed because it's been proved.

For more details, see your Armstrong Representative and start living . . .

P. S. Like some good meaty reading? Ask for the 48-page Armstrong Steam Trap Book.

ARMSTRONG MACHINE WORKS

8588 MAPLE STREET
THREE RIVERS, MICHIGAN

"See our Catalog in Chemical
Engineering Catalog"

011-57



Scales.....Complete information on how modern scales will fit your needs...whatever your weighing problem is contained in Condensed Catalog 2001.
180a *Toledo Scale

Track Scales.....with Type S lever system for accuracy weigh more railroad cars than any other scale. Further information on these scales is available on request.
40 *Fairbanks, Morse & Co.

Tractor-Shovel.....Model H-25 Pay-loader had dual-filtering of engine intake. "Industrial Materials Handling from A to Z" is available for details.
39 *The Frank G. Hough Co.

Heating & Cooling

Air Preheaters.....Ljungstrom package air preheaters for use on boilers from 25,000 to 250,000 pounds of steam per hour. Details in 14-page booklet.
87 *The Air Preheater Corp.

Aluminum Cooling Towers.....Literature is available giving information on aluminum cooling towers and their treatment and may be had upon request.
195d *Aluminum Co. of America

Chlorinator.....V-notch chlorinators provide the economical answer to water- and waste-treatment problems. More information is available.
153 *Wallace & Tiernan Inc.

Electric Heaters.....Chromalox Flange-Type Electrical Immersion Heaters are ideal for high-temperature/high-pressure applications. Details in catalog 60.
R177 *Edwin L. Wiegand Company

Heat Exchangers.....This light & compact heat exchange surface is being used in more & more installations where superior performance is essential. Information.
10-11 *Trane Co.

Heat Exchangers.....Heat exchanger Division of Western Supply Co. designs and fabricates Fixed Tube Sheet, U-tube, and Floating Head Exchangers. Information available.
157 *Western Supply Company

Heat Exchanger Tubes.....Literature is available giving information on Alcoa Aluminum Heat Exchanger Tubes and may be had upon request.
195d *Aluminum Co. of America

Heater, Fired.....Petrochem Vertical and Horizontal Heaters can be built in every size and type for every use in any location. Complete details are available.
47 *Yuba Consolidated Industries

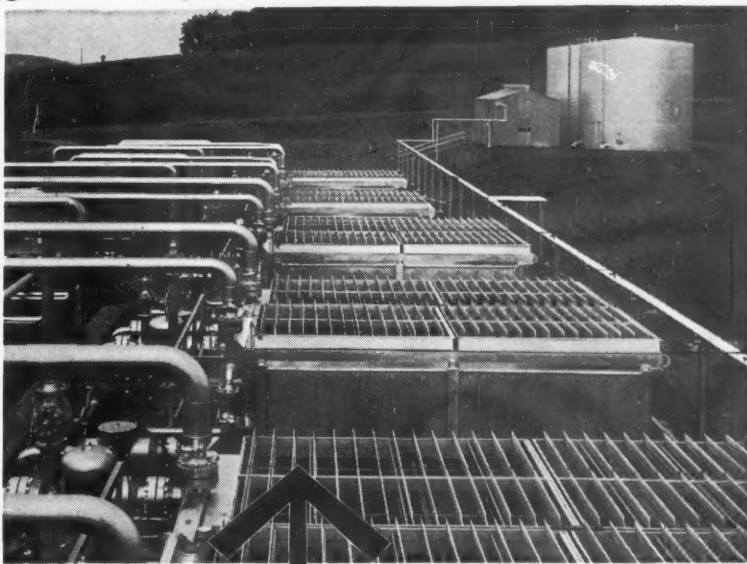
Heating Mantles.....Safe, dependable electric heating mantles for every use. A bulletin is available for more detailed information and may be had upon request.
36 *Glas-Col Apparatus Company

Make-Up Air Systems.....Fans bring in outside air, and heaters temper it. Cancels out vacuum, gives balanced heat & ventilation. A booklet is available.
63 *Sturtevant Div., Westinghouse

* From advertisement, this issue

from ALCOA

good designs made better with aluminum



Alumi-Louvers provide dependable, economical ventilation at New York State Natural Gas Co.

For uninterrupted, maintenance-free performance, Mansfield Metal Fabricating Co., Mansfield, Ohio, constructs its famous *Alumi-Louvers* of Alcoa® Aluminum. A typical installation (shown) is at New York State Natural Gas Co., Tamarack, Pa. *Alumi-Louvers* require no maintenance, provide dependable, economical control of ventilation and temperature. Mansfield reports that lightweight aluminum cuts transportation and installation costs (special rigging is unnecessary). For more information about corrosion-resistant aluminum, please send the coupon.



Aluminum Company of America, 825-VV Alcoa Building, Pittsburgh 19, Pa.

Please send me the following literature covering Alcoa Aluminum for tubular products and other uses in the process industries.

- ☐ 68-10460 *Process Industries Applications of Alcoa Aluminum*
- ☐ 42-20849 *Resistance of Aluminum Alloys to Weathering and Resistance of Aluminum Alloys to Chemically Contaminated Atmospheres*
- ☐ 61-21088 *Aluminum Cooling Towers and Their Treatment*
- ☐ 34-11566 *Alcoa Aluminum Heat Exchanger Tubes*

Name _____ Title _____

Company _____

Address _____

City _____ Zone _____ State _____

CRYOGENICS

Helium

**Refrigerators 4°-20°K
Recovery-Purifier Plants
Liquid Storage
and Transport
Cryostats**

Helium is one of the most valuable, most inert and most difficult gases to handle en masse in liquid state. One of Cryenco's special interests is designing and building custom helium equipment. Cryenco has designed refrigerators for the temperature range of 4°-20°K with small and large capacities. One of Cryenco's recovery-purifier plants produces Grade A helium at a rate of over 100 SCFM. Cryenco's efficient helium dewars and tanks range from 100 liters to 7000 gallons. Special 4° cryostats are also available. Let Cryenco handle your helium problems and free your physicists and engineers for fundamental work. Write for quotation on your specific requirement.

CRYENCO

Cryogenic Engineering Co.
215 W. 48th Ave., Denver 16, Colo.
Low Temperature, High Vacuum
Equipment and Engineering

LITERATURE . . .

Steam Traps......The 48-page book gives complete information and details on steam traps. Also information on design, construction and operation of Inverted Bucket Trap. 194 *Armstrong Machine Works

Steam Traps......Thermostatic steam traps operate on a true balanced vapor-pressure principle, they discharge air, condensates & other non-condensables. Cat. 400. 203 *W. H. Nicholson & Co.

Instruments & Controls

Air Comparison Pycnometer......new Beckman Model 930 is a revolutionary means of making volume measurements. For details, write for Data File 14-34-23. R215 *Beckman Instruments, Inc.

Computer.....Recomp 11 has exclusive built-in floating point arithmetic. Also features built-in square root command and automatic conversion from decimal to binary. 26 *Autonetic Div., N. Amer. Avia.

Computer.....G-15 is the leader among small and medium-scale computers. Features superior performance, real economy & proven support. Information is offered. 79 *Bendix Computer Div.

Electronic Controllers......Consotrols can save space, save time, save money. Further information on the advantages of these electronic controllers in Bulletin 9-12. 18-19 *The Foxboro Company

Flow Meter......B-I-F's unique plastic insert Dall Flow Tube is completely corrosion-resistant in construction. Request Facts booklet. L216 *B-I-F Industries

Gage......Liquid level gage sets guarantee clearer visibility, unmatched accuracy at temperatures from sub-zero to 750°F. Complete information available. 166 *Penberthy Manufacturing Company

Lined Gage......For handling corrosive liquids and gasses, Jerguson Gages are lined with natural and synthetic rubber, lead, and other materials. Drawings GD-1306, 1307. R176 *Jerguson Gage & Valve Company

Liquid Level Control......Magnetrol will handle almost any liquid, at any temperature at any pressure with same precision and dependability. Information. T179 *Magnetrol, Inc.

Meters......guard your liquid inventories and control the flow of industrial liquids. You'll have accurate records of cost plus other advantages. 143 *Rockwell Mfg. Co.

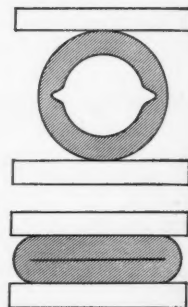
Pressure Controller......is available in brass, steel or stainless steel Bourdon tubes or ranges from 25 to 10,000 psi. Bulletin D 4150A is available. BR200 *Fisher Governor Company

Pressure Controls.....for machine tool hydraulic systems operating at pressures up to 5000 psi. Has oil-tight enclosure. Write for Bulletin 836. 159G *Allen-Bradley Co.

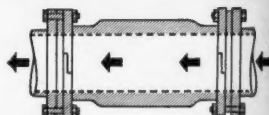
*From advertisement, this issue

Massco-Grigsby PINCH VALVES

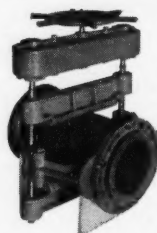
**"Hinged" sleeve
permits tight closing
reduces wear.**



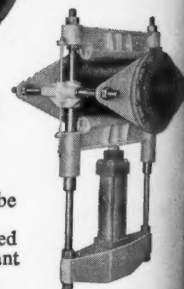
**Recesses in sleeve serve as
"hinges" during compression.**



**Unobstructed flow eliminates high
friction loss; and there are no metal
parts in contact with pulp or liquid.**



**Several types of
closing mechanisms
are available, from
handwheel to
motorized.**



Automated Systems.

**Completely
automatic
systems may be
coordinated
and interlocked
with other plant
equipment.**

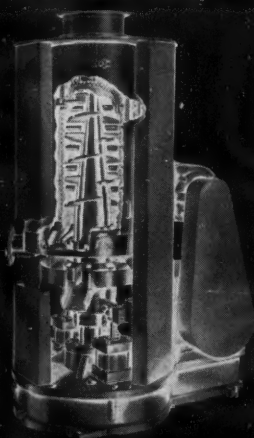
**1" to 14" I.D.; pressures to 150 psi,
temperatures to 200° F.**

WRITE FOR CATALOG 609

MINE AND SMELTER SUPPLY CO.

**3800 RACE STREET • DENVER, COLORADO
OFFICES AND AGENTS IN PRINCIPAL CITIES**

ANNOUNCING THE NEW



ZENITH PRESSMASTER

CONTINUOUS PRESS

The new Zenith Pressmaster is the culmination of 30 years of press engineering and 400 installations.

IS VERSATILE

Dewaters, virtually all fluid-yielding solids... cellulose, pulps, polymers, plastics, and many other materials.

IS ECONOMIC

Self-adjusting, continuous, automatic operation. Slashes costs. No operator required. Near zero maintenance.

IS DEPENDABLE

Maintains uniform product, high yields. Heavy duty construction; holds exact spindle and screen alignment.

IS NON-CONTAMINATING

Meets rigid sanitation requirements in food industry. Self-lubricating bearings and completely enclosed drive eliminate contamination. Easily and thoroughly cleaned by one man in 15 minutes. Quick-opening for full interior inspection.

For full information

CALL COLLECT:

Zenith Press Division

Hillcrest 3-4411, ext. 502

Pittsfield, 1, Massachusetts



Jones

ZENITH PRESS DIVISION

LITERATURE . . .

Process Instrumentation.....Booklet Number 310 is a brief, conveniently condensed presentation of the more prominent precision devices in the line.
12-13a *Fischer & Porter Co.

Pump Control Panels.....Complete units for automatic operation of irrigation and oil well pumps. For more information, write for Bulletin 1232.
159c *Allen-Bradley Co.

Rotameter.....The frame of the new Varea-meter is in one rigid piece. Varea-meters come in $\frac{3}{4}$ " through 3" sizes with 5" and 10" scales. Information is offered.
152 *Wallace & Tiernan, Inc.

Speed Regulators.....provide manual speed control of wound rotor motors for either fan or machine duty. Further information is provided in Bulletin 555.
159d *Allen-Bradley Co.

Transmitters....New pneumatic bellows flow transmitter makes range changes simply. New pneumatic temperature transmitter offers thermal system options.
42 *Minneapolis-Honeywell

Pipes, Fittings & Valves

Aluminum Pipe & Fittings.....A booklet describing aluminum pipe and fittings and their various applications and dimensions is available on request.
191a *Aluminum Co. of America

Globe Valves.....feature less corrosion attack because of elimination of cavity between stem and disc. Full information is to be found in Bulletin #7 which is available.
32 *Alloy Steel Products Co.

Heat Exchanger Tube.....Trufin type S/T tube is available in a wide range of alloys & sizes. Trufin type S/T Duplex is also available for use as an outer tube. Inform.
95-96 *Wolverine Tube, Div. of Calumet

Pinch Valve Systems.....Massco-Grigsby Hydral-60 system consists of one or more pinch valves with a single automatically operated hydraulic Pump. Catalog 60A
R196 *Mine & Smelter Supply Co.

Pipe.....Saran Lined Pipe, fittings, valves and pumps are available for systems operating from vacuum to 300 psi, from below zero to 200 F. Information.
52 *Saran Lined Pipe Co.

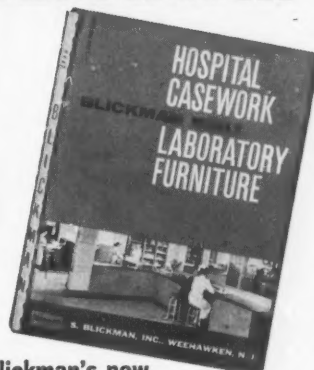
Pipe Product.....A technical report on Duotrace, a product which contains two trace passages & a product passage integrally extruded in a single pipe is offered.
191c *Aluminum Co. of America

Piping.....A 24-page illustrated brochure, "Power & Process Piping" describes this company's capabilities in the fabrication and erection of piping plus case histories.
91 *Midwest Piping

Piping & Tracing....A bulletin describing Unitrace which combines piping and tracing in one unit is offered and may be had upon request.
191b *Aluminum Co. of America

*From advertisement, this issue

specify BLICKMAN- BUILT® laboratory furniture and hospital casework!



Blickman's new 40-page catalog provides a quick-reference implement for basic planning of laboratory and hospital installations.

It includes specifications for standard and specialized laboratory furniture, and fixtures...PLUS details of Blickman's exclusive CONFLEX* construction. This new concept achieves maximum flexibility of door and drawer arrangements, without the use of tools...and without loss of rigidity or structural soundness!

More than 75 years of manufacturing experience stand behind the famed Blickman-Built symbol. It identifies the finest in stainless and enameled steel equipment!

*TRADE MARK

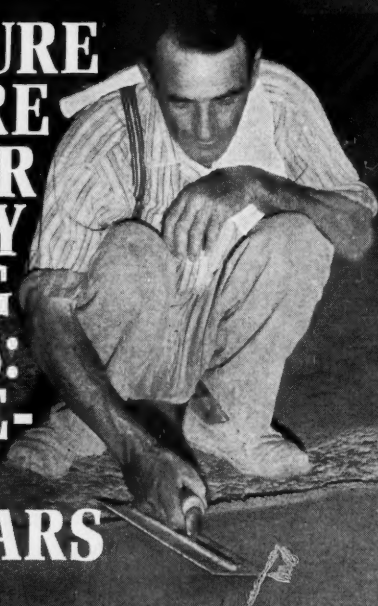
SEND FOR YOUR COPY TODAY!

S. BLICKMAN, INC.

8908 GREGORY AVE., WEEHAWKEN, N. J.

Gentlemen:
Please rush my copy of your Hospital Casework and Laboratory Furniture catalog.
company _____
name _____
address _____
city _____ state _____

SURE CURE FOR CHRONICALLY FAILING FLOORS: POLYSULFIDE- BASE MORTARS



In more and more industrial buildings where manufacturing processes have raised havoc with conventional floors and have caused a continuing cycle of restoration, THIOKOL polysulfide-base flooring compounds are delivering long trouble-free service and decreasing maintenance costs.

THIOKOL polysulfide polymer is synthetic rubber in liquid form. It is famous for spectacular adhesion, elasticity, and resistance to oils, solvents, acids, chemicals, water and temperature extremes. As a mortar base with epoxy, it stands up to heavy traffic, abrasion, chemical attack like no other flooring compound. It can be applied

over existing surfaces regardless of their composition, and has proven its serviceability in scores of installations.

Polysulfide-base mortars provide a smooth or skidproof surface, as desired—are ready for traffic in less than one day—and last for years under abusive wear and exposure to disintegrating elements. For full information, write to Thiokol Chemical Corporation at address below, for Brochure FC-100.

Thiokol®

CHEMICAL CORPORATION
780 N. Clinton Ave., Trenton 7, N.J.
In Canada: Naugatuck Chemicals Division,
Dominion Rubber Company, Elmira, Ontario

LITERATURE . . .

Piping, Valves and Fittings, Jackets . . . designed with extra metal thickness in walls and flanges. Send for Catalog 356 and Supplement 356-S. L214 *Parks-Cramer Co.

Tubing Excelon tubing nationally distributed for industrial and laboratory uses and whenever flexibility, clarity and chemical inertness is required.

TR216 *Thermoplastic Processes, Inc.

Valves The right valves for any chemical installation offering a complete line of valve materials, both ferrous and nonferrous. Information. 103 *The Wm. Powell Company

Valves Ram type drain valves are designed so that in the closed position the piston or ram extends up into the tank. In open position full low is assured. Catalog. T178 *Strahman Valves, Inc.

Valves Gate, Globe and Check valves with hard faced seats feature interchangeable parts. Complete line of pressures, sizes & types. Literature. 106 *Henry Vogt Machine Co.

Valves, Diaphragm resist attack by hot corrosives. The diaphragm lifts high for streamline flow-seals tight for positive closure. Further information. 174 *Grinnell Company

Process Equipment

Bird Continuous Centrifugals Pilot scale test data on Bird's complete line of solid-liquid separating equipment is available on request. 2 *Bird Machine Company

Centrifuge Reineveld centrifuge processes thickened underflow from each cyclone stage in centrifuge operations. Write for information. 199b *Heyl & Patterson, Inc.

Compacting Process produces granules that are more uniform in size, that flow free and won't fracture or abrade in handling. Complete information is offered. 14-15e *Allis-Chalmers

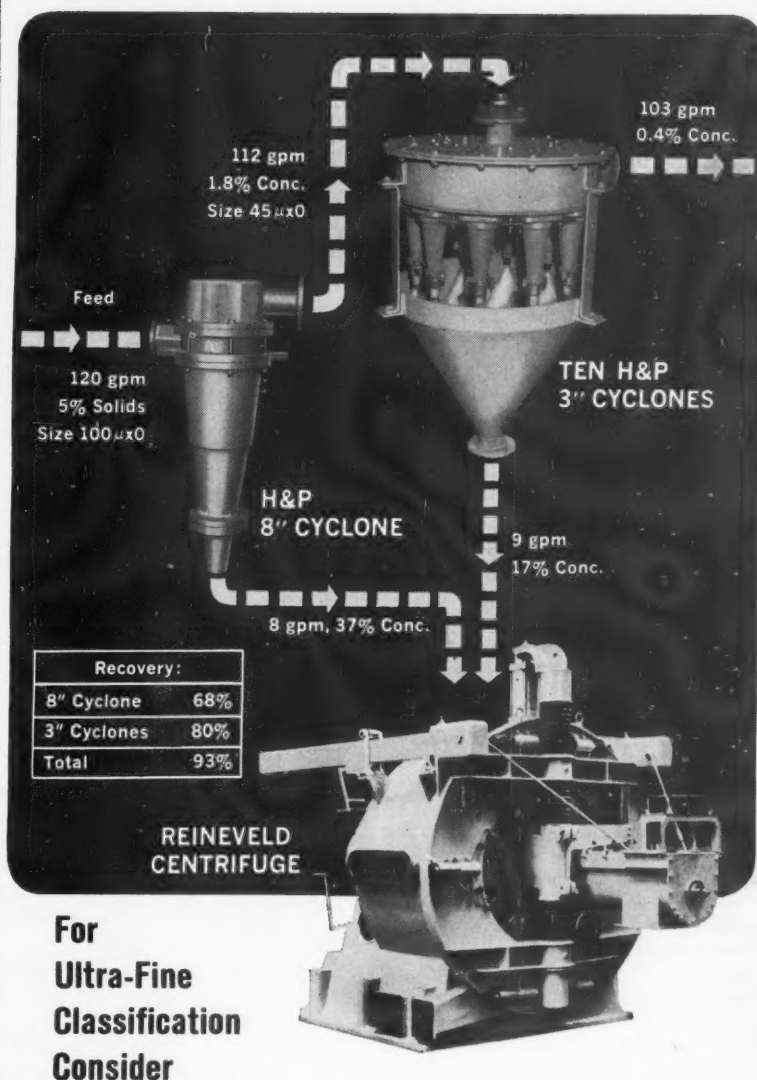
Cyclone Thickeners cut down cost and increase efficiency when added to Centrifuge installations. Write for complete information. 199a *Heyl & Patterson, Inc.

Dissolver Hi-Shear Cowles Dissolver unit has high quality yet saves 80% in labor costs. Write for complete information. L217 *Morehouse Cowles, Inc.

Double Drum Dryer Model 2-28-60 has several special features for drying a chemical compound. Drums are chrome plated, have speeds of 1½ to 10 R.P.M. Catalog "A". TR175 *Davenport Machine and Foundry Co.

Dryer Complete information on vacuum chamber dryers is available on request. Special designs to solve your chemical processing problems. 188 J. P. Devine Mfg. Co.

NEW WAY TO SAVE MONEY



For
Ultra-Fine
Classification
Consider

Heyl & Patterson's Money-Saving Combination

By adding inexpensive Cyclone Thickeners to Centrifuge installations, a preponderance of the liquor and nearly all of the undesirable solids in the near zero range can be removed before the feed reaches the centrifuge.

Only the thickened underflow from each cyclone stage is processed by the centrifuge. Obviously, its effectiveness and capacity are greatly increased.

Write or phone us for additional information or request a visit to discuss your centrifuge operations. We will then make practical recommendations, introducing the Money-Saving H & P Cyclone into your process.

HEYL & PATTERSON, inc.

55 FORT PITT BLVD., PITTSBURGH 22, PA., COURT 1-0750



*From advertisement, this issue

Sturtevant Equipment

NEWS



Vertical air-swept impact mill with integral air classifier

Sturtevant Pulver-Mill® does in one step what used to take two

Designed for fine grinding into the micron range and precise end product classification — all in a single operation, Sturtevant Pulver-Mills are proving highly effective for pulverizing soft to medium hard non-metallic materials. ■ *In Ag chemicals*, Pulver-Mills have helped one blue chip company enter and compete profitably in the lucrative 95% 325 mesh market . . . *In the milling field*, too, Pulver-Mills are increasing yield while also improving uniformity of particle size . . . *And pilot runs* at Sturtevant's laboratory indicate that Pulver-Mills can lower production costs, improve quality control, in the pulverizing of dozens of other materials. ■ Air-swept principle of operation (special intake vane design "whirls" vertical air flow) enables both control of attritional heat and integral air classification of end product. Precise selection of desired particle size is accomplished by an adjustable selector bar system. Unique deflector wall design "bounces" any partially reduced material back into the Pulver-Mill grinding zone — makes the reduction process (revolving impactors passing between fixed wall impactors) fast, highly efficient. ■ Now available in three models with capacities ranging from several hundred pounds per hour to 7½ tons per hour, Sturtevant will welcome the opportunity to test-run any soft to medium hard non-metallic material you may be working with.

For further information, send for Sturtevant Bulletin No. 093. Write Sturtevant Mill Co., 100 Clayton St., Boston 22, Mass.

S STURTEVANT 85 years of design leadership in Air Classifiers, Micron-Grinders, Pulverizers, Blenders, Crushers, Grinders.

OIL-LESS AIR COMPRESSORS, VACUUM PUMPS, .35 TO 24 C.F.M.

INTEGRAL-MOTOR AIR PUMPS .6 TO 3.8 C.F.M.

LIGHT-DUTY MODELS, .6 TO 24 C.F.M. V-BELT OR COUPLING

HEAVY-DUTY AIR COMPRESSORS, VACUUM PUMPS, 4 TO 50 C.F.M.

GAST VACUUM PUMPS and AIR COMPRESSORS

Extra dependability for plant use . . . for O.E.M.

Need a source of low pressure air or moderate vacuum? Check with Gast! Save money, time, effort in choosing the best air pump for your job.

Precision quality and rotary design provide outstanding dependability. Vanes take up their own wear . . . maintaining like-new performance. Quiet, non-pulsating air . . . no tank needed! Oil-less or lubricated models—direct coupling, V-belt or integral-motor drives. Sizes from 1/40 to 5 h.p., .35 to 50 c.f.m. Vacuum to 28" Hg, pressure to 30 p.s.i.g.

WRITE TODAY FOR CATALOG! If you can, specify pump type you need.

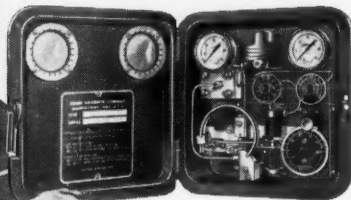
AIR MOTORS • VACUUM PUMPS • COMPRESSORS



GAST MANUFACTURING CORP.
P. O. BOX 117-S, BENTON HARBOR, MICHIGAN

So many ways the FISHER/MAN can give you a helping hand with the

WIZARD II PRESSURE CONTROLLERS



- Two Position Controller
- Proportional Controller
- Proportional Controller—Remote Set
- Differential Proportional Controller
- Pressure Transmitter
- Differential Proportional Controller—Remote Set
- Proportional Reset Controller
- Differential Proportional Reset

This "Jack of ALL Trades" is surprisingly low in cost

The partial list of applications at left tells you why the Wizard II is so aptly named. Probably no other controller in the Fisher line is as versatile. Available in brass, steel or stainless steel Bourdon tubes for ranges from 25 to 10,000 psi. Brass or stainless steel bellows available for low pressure service from 30" Hg Vacuum to 30 psi. Write for Bulletin D 4150 A.



IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD... IT'S CONTROLLED BY...
FISHER GOVERNOR COMPANY
Marshalltown, Iowa / Woodstock, Ontario / London, England
CONTINENTAL EQUIPMENT CO. DIVISION, Coraopolis, Pennsylvania



LITERATURE . . .

Dryer....Lectrodryer offers continuous or intermittent operation. Packaged. Steam, gas or electric reactivation. Drying Facts are available.
192 *McGraw-Edison Co.

Evaporators.....Long Tube Vertical Evaporator boasts accessibility of major components for easy inspection and maintenance. Write for technical bulletin.
184 *Swenson Evaporator Company

Filter Press.....can be used for a multitude of applications—go from one chamber to full capacity. The Sperry Catalog is available for information.
53 *D. R. Sperry & Co.

Filteraids.....Bulletin B-14 discusses the principles and operating practices of filteraid filtration, and its applications in many industries.
190 *Dicalite Department

Filters... High performance is achieved by these filters as a result of co-operative engineering in pilot plant and design stages. Details in Bul. PE-2049.
COV *The Eimco Corp.

Filters.....Duo double duty fluid filter is sealed at each end to eliminate trespassing. In bronze, steel, 316 stainless steel & aluminum. Full data is offered.
B178 *Ronningen-Petter Co.

Filters.... Micro-Filters for fine filtration operations. All the facts about Micro-Filters are contained in Bulletin MF-1 which is available on request.
R200 *Selas Flotronics, Selas Corp.

Flash Drying Systems.....offer flexibility in application. This is a versatile system that can be readily adapted to your particular problem. Catalog #82E.
104b *Combustion Engrg. Inc.

Gyratory Screen.....features stacked-deck design to conserve valuable space. Cuts maintenance and downtime with all-stainless steel construction. Details.
14-15a *Allis-Chalmers

Hammer Mill....Many exclusive features, unavailable in other equipment, promise ultimate economy. A catalog is available on request for further details.
181 *Williams Patent Crusher

IMP Mill....Catalog 87E shows the many applications of this multi-purpose grinding unit such as grinding, blending, separating, conveying, & drying.
104a *Combustion Engineering, Inc.

Mill....Pulver-Mill does in one step what used to take two. Designed for fine grinding and precise end product classification. Bulletin 093.
L200 *Sturtevant Mill Co.

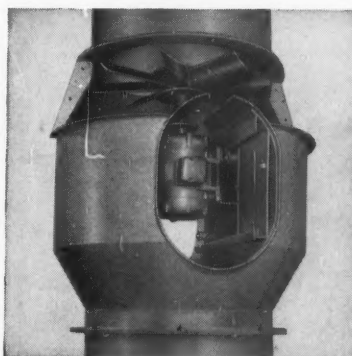
Mole-u-Dryer....A new type MSX molecu-dryer has been developed to supply pure, dry air at 100 deg. F. & solve instrument air problems. Full details in Bulletin 1060C.
L176 *C. I. Hayes, Inc.

Precipitators....Superior precipitator performance is helped by Buell's exclusive emitting system. Send for complete information on Buell's precipitators.
33 *Buell Engineering Co., Inc.

*From advertisement, this issue



SLIDE-OUT MOTOR AND FAN* cut your maintenance costs



Simply removing patented half-section of cone (left) allows motor-and-fan assembly to slide on rails (above) right out of DeBothezat Bifurcator for quick and easy inspection and maintenance. Bifurcator housing, originally installed as a section of the duct work, remains in place. This ease and convenience result in quick work which sharply cuts your maintenance costs.

DIRECT DRIVE CUTS COSTS, TOO

Direct drive eliminates inefficiency and maintenance problems of belts, yet motor operates in cool, clean air. Twin ducts of Bifurcator carry abnormally hot, corrosive or explosive fumes around motor, isolate it from destructive fumes handled by direct-drive exhaust fan. Fan wheels available from 12" to 48".

*Optional extra. Patents Pending.

Write for illustrated Bulletin DB-7-61

De Bothezat®

DE BOTHEZAT FANS DIVISION OF
American Machine and Metals, Inc.
Dept. CED-861, EAST MOLINE, ILLINOIS

Divisions of American Machine and Metals, Inc.

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Ceramo® Performance—

*...Your Best Indication
of Unsurpassed
Quality!*



"Ceramo" Performance in your most severe temperature measuring applications is your best indication of "Ceramo" Superiority! This metal sheathed, ceramic insulated thermocouple wire—used for all types of thermocouples—assures rapid response and consistent accuracy—long life with stability!

Developed by Thermo Electric Co., Inc. more than ten years ago, "Ceramo" has mastered the most difficult temperature measuring jobs; jet engines, nuclear reactors, exotic missile and rocket fuel tests, and many others, equally severe. It can be formed to practically any configuration without insulation loss and withstands extremely high pressures in measuring temperatures from minus 450°F. to plus 4000°F., and over!

Careful Manufacture

"Ceramo" is closely supervised throughout production, to assure accuracy and uniformity. In our own wire mill—the wire elements are drawn, carefully calibrated and rigidly tested for spurious emf. generation. Various inert metallic oxide insulating materials are specially processed for purity. Sheath

materials are scrupulously inspected for continuity and sheath integrity. The finished "Ceramo" wires are heat-treated and annealed for proper ductility and stabilization.

Rigid Quality Controls

Quality Controls and Inspection for "Ceramo" production exceed the requirements of MIL-Q-9858, 4/9/59, "Quality Control System Requirements".

Many Types Available

"Ceramo" thermocouple wires are available in single, duplex, four and six conductor types, of standard thermocouple elements, including various Platinum-Rhodium combinations, and special Iridium-Rhodium and Tungsten-Rhenium calibrations. Wire gage sizes range from 36 to 12; outside diameters from 1/25" to 7/16". Sheath materials are available in Stainless Steels, Inconel, Aluminum, Platinum or Copper. Lengths to 30 feet are stocked—lengths to 60 feet can be supplied.

*When You Must Be Sure—Specify "Ceramo"
by Thermo Electric!*

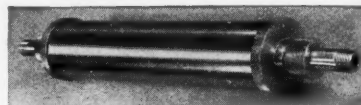
Write today for "Ceramo" Bulletin 31-4

THERMO ELECTRIC Co., Inc., Saddle Brook, New Jersey
In Canada: THERMO ELECTRIC (Canada) LTD., Brampton, Ont.

**Thermo
Electric**

20 YEARS • Temperature Measuring Systems and Components

SELAS MICRO-FILTERS provide compact, production-line methods for fine filtration



SELAS MICRO-FILTERS eliminate intricate set-ups requiring complicated apparatus and provide more-compact and efficient methods to handle the entire range of fine-filtration operations—from preliminary clarification to final sterilization.

Utilizing inert, micro-porous porcelain filter elements, SELAS MICRO-FILTERS provide distinct advancements in critical, fine-filtration techniques, which can increase production and lower costs . . . for pharmaceutical, bacteriological and biological groups, as well as for the fine-chemical and food industries.

Units can be readily installed in a metal or glass pipe, or rubber hose line, and easily removed from flow line without use of tools.

Bulletin MF-1 contains all the facts. For your copy, write:

SELAS
Flotronics

Spring House, Pa.
A Division of Selas Corporation of America

LITERATURE . . .

Pressmaster dewaters virtually all fluid yielding solids, maintains uniform product, high yields. Further information is available on request.
L197 *Zenith Press Division

Pressure Filter Vallez rotating leaf pressure filters can be completely controlled by automation. Complete detailed information is available.

R217 *Goslin-Birmingham Mfg. Co. Inc

Purifiers Hi-eF Purifiers have patented two-stage principle of separation with no moving parts. Special Manual 803 contains data on 13 types of separators.

T183 *The V. D. Anderson Company

Scrubber Type VO Oriclone scrubber for ultra-efficient dust and fume control. Requires 50% less space than other high energy scrubbers. Detailed information.
139 *The Ducon Company

Thickeners with "auto-raise" device, manual or power raise, replaceable ring-type ball bearing support, spiral rakes, and "froth rings." Request Bulletin 31-D-11.
158 *Hardinge Company, Inc.

Pumps, Fans & Compressors

Centrifugal Air Compressors are the plus factor in modern oxygen plants for steelmaking. Detailed information on these Isotemp compressors is available.
141 *Clark Bros. Co.

Compressors, Dynamic in sizes from 15 to 15,000 hp. Complete performance profile for every compressor manufactured. Information in Bulletin 2563-11.
85 *Joy Manufacturing Co.

Fan New design duct fan by De Bothezat has a removable cone design. Descriptive literature on this new type is available on request.
201 *American Machine & Metals, Inc.

Metering Pumps Add-on metering pumps let you buy only what you need today . . . add to it when your requirements change. Literature is available for details.
133 *Hills-McCanna Co.

Pneumatic Equipment Air motors, compressors and vacuum pumps for low-cost solutions to your problems. Catalog is available.
TR200 *Gast Manufacturing Corp.

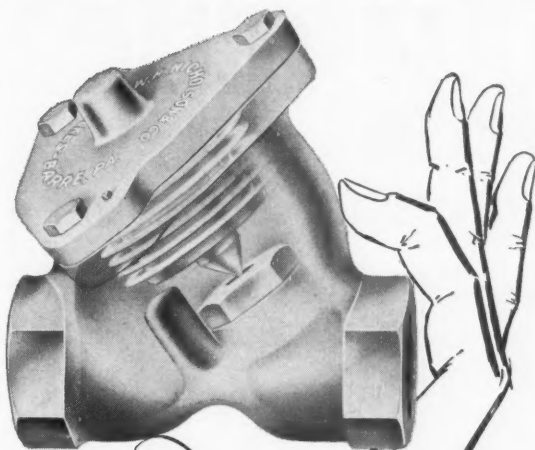
Pumps Triplex pumps cost less to run and maintain. With high or low pressure, they are vibration-free and in perfect balance. Capacities from 50 to 7500 GPH.
73 *Manton Gaulin Mfg. Co.

Pumps Karbate frame-mounted Type F pumps have been added to the line of impervious graphite pumps. Details on models and sizes are available on request.
149 *National Carbon Company

Pumps, Controlled Volume A general introduction to controlled volume pumping is contained in Bulletin 553-1 which is available upon request.
4 *Milton Roy Company

*From advertisement, this issue

This **LITTLE** trap does a **BIG** trapping job — and reduces the cost of discharging condensate



NEW NICHOLSON N-150 THERMOSTATIC STEAM TRAP

- ... All steel construction for rugged durability.
- ... Design simplified for quick, low cost maintenance.
- ... Compact, lightweight, easily installed. Can be inspected without breaking pipe connections.
- ... Equipped with Nicholson steam-saving Baffle*.



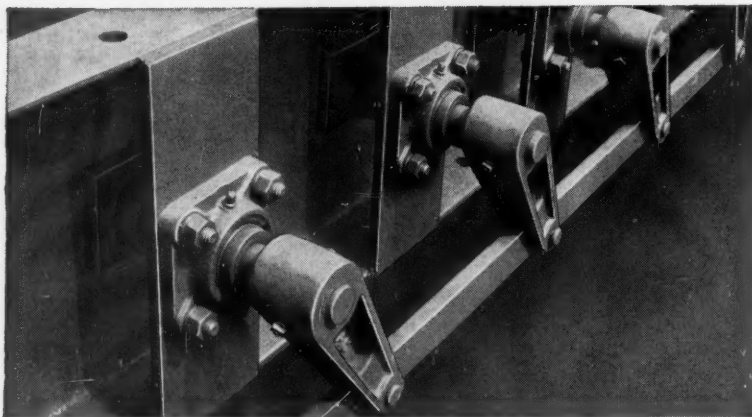
For lowest cost-per-pound of condensate handled, this trap is by far your best buy. Like all Nicholson Thermostatic Traps, it opens **ONLY** when necessary . . . that is, when sufficient condensate collects in trap body to surround the Monel bellows . . . **ONLY** then does the pressure inside the bellows reduce below line pressure, the resulting differential causing bellows to contract and instantly activate complete discharge. Body is cast steel and cover forged steel. Cover screws, valve and valve seat are hardened stainless steel. Just *one* working part, so maintenance is practically nil. In 1/2" and 3/4" sizes. For pressures from vacuum to 150 psig. Write for details, including the name of the Nicholson man in your area.

*Patent applied for

W. H. NICHOLSON and COMPANY
12 Oregon Street • Wilkes-Barre, Pa.



CUSTOM-DESIGNED WHIRLEX DAMPERS FOR POSITIVE DRAFT CONTROL



Whirlex multi-louvered dampers give positive control of your draft problems. Whatever your requirements, Whirlex dampers are custom-engineered, in both louvered and opposed-blade designs, for all types and sizes of applications. And, whether in difficult conditions requiring gas-tight seals and closure strips, or linkages for operating with combustion control equipment, or dust-seal equipped bearings for pressure systems, Whirlex offers equipment *custom designed* to meet your needs.

Whirlex all-welded dampers are completely intergrated and shop-assembled. They assure you of quality controlled, high-efficiency equipment with a consistently low operating and maintenance cost.



Remember, when Whirlex multi-louvered dampers work for you, you get the *best* draft control for the *least* cost. Ask for bulletin #DA-16

THE FLY ASH ARRESTOR CORP
205 North 1st Street / Birmingham, Alabama
1355 Market Street / 420 Lexington Avenue
San Francisco 3, Calif. / New York 17, N.Y.

Bag Collectors — Mechanical Collectors — Wet Collectors
Induced Draft Fans — Forced Draft Fans — Exhaust Fans
Self Supporting Stacks — Duct Work



LITERATURE . . .

Rotary Compressors.....Bulletin 11003 describes Type L Axi-compressors while Bulletin 11015 contains information on Type H units. Both available on request.
51 *Ingersoll-Rand

Rotary Pump.....Damaging corrosives, problem liquids of varying viscosities are kept on stream with Waukesha industrial rotary pumps. Write for catalog P-333.
164 *Waukesha Foundry Co.

Services & Miscellaneous

Chemical Plant.....Chemical companies interested in expanding their manufacturing facilities are invited to write for the current 12-page Kelloggram.
50 *The M. W. Kellogg Company

Dampers.....Whirlex multi-louvered dampers give positive control of draft problems. Custom-designed equipment to meet customer needs. Write for Bulletin #DA-16.
204 *The Fly Ash Arrestor Corp.

Helium Equipment.....Cryenco has a special interest in designing helium equipment to suit your needs. Write for information and quotation.
L196 *Cryogenic Engineering Co.

Laboratory Furniture.....A new 40-page catalog provides a quick reference implement for basic planning of laboratory & hospital installations. Available on request.
R197 *S. Blickman, Inc.

Phase Reversal Relays.....Write for Bulletin 812 for detailed information concerning Allen-Bradley's Style F, Style R and Style RF relays.
159a *Allen-Bradley Co.

Printed Weight Records.....New Print-weight "400" prints complete weight records on tickets or sheets, also on strips. Time & data printing available. Bulletin 2017.
180b *Toledo Scale Corp.

Skylights.....Wasco Twin Dome skylights are completely sealed, insulated and shatterproof. Inner & outer domes available in any combination. Information.
24-25b *American Cyanamid Co.

Thermocouple Wire.....This metal sheathed, ceramic insulated thermocouple wire is used for all types of thermocouples. "Ceramo" Bulletin 31-4.
L200 *Thermo Electric Co., Inc.

Tube Cleaner.....for condenser and heat exchanger tubes. They feature pistol-grip, chrome-moly shafting and flushing action. Bulletin Y-48 is offered.
R205 *Elliott Company

Waste & Refuse Storage.....Dump-master system features out-of-sight waste & refuse storage for your plant. You may own the system or secure service from a hauler. Brochure.
92 *Dempster Brothers, Inc.

Water Softener.....Zeolite water softener means a simple switch to sodium ions from the usual hardness present in water supplies. Further details are available.
14-15c *Allis Chalmers

*From advertisement, this issue

a 11003
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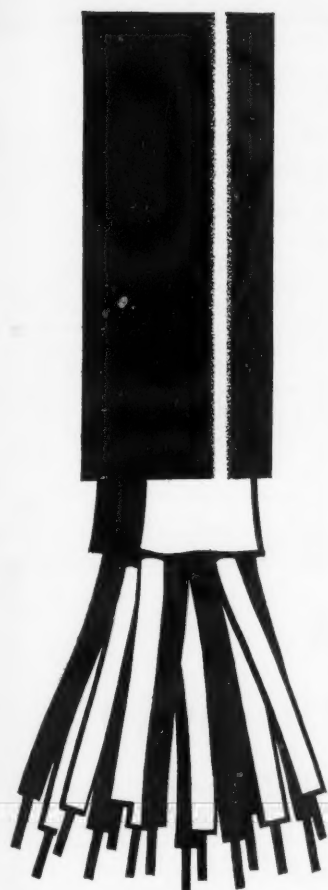
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MULTIPLE-CONDUCTOR T/C EXTENSION CABLE

Available with from 4 to 48 pairs of solid-conductor temperature-compensated wires. Each wire is numbered, individual conductors are twisted into pairs, each pair is color-coded by wire type. No conduit needed. Supplied in custom and standard constructions. From this one dependable source come thousands of other accessories to help your instruments perform at their very best.

Get details from your Honeywell field engineer, or write today for Catalog G100-2.

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First in Control
SINCE 1899

newest ELLIOTT tube cleaner

lightweight! air-driven!



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easy to handle by one operator

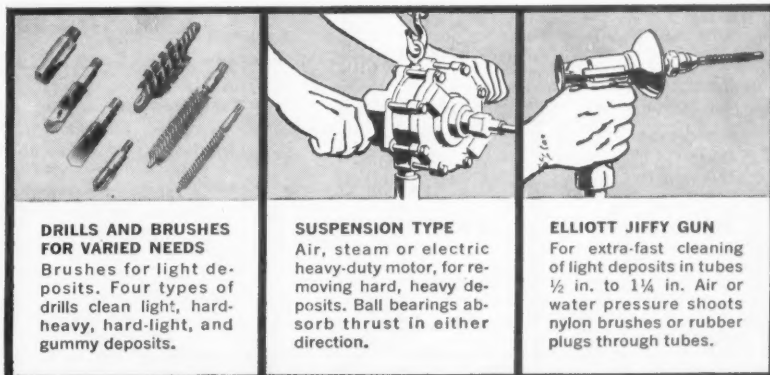
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(Aircraft quality) for greater strength and rigidity

FLUSHING ACTION
hole near drill tip for cooling and flushing water

for condenser and heat exchanger tubes

Lightweight. Powerful. Air-driven. Trigger-action control with speed governor to prevent shaft-whip. High-speed motor reduced through planetary gears to 1500 rpm. Integral

water-feeding attachment with finger-action valve which controls flow of cooling water into hollow shaft and drill or brush. Built-in oil reservoir. Send for tube cleaner bulletin Y-48.



DRILLS AND BRUSHES FOR VARIOUS NEEDS
Brushes for light deposits. Four types of drills clean light, hard-heavy, hard-light, and gummy deposits.

SUSPENSION TYPE
Air, steam or electric heavy-duty motor, for removing hard, heavy deposits. Ball bearings absorb thrust in either direction.

ELLIOTT JIFFY GUN
For extra-fast cleaning of light deposits in tubes 1/2 in. to 1 1/4 in. Air or water pressure shoots nylon brushes or rubber plugs through tubes.

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The philosophy of fine engineering which prevails at The M. W. Kellogg Co. is largely responsible for the Company's leadership, acknowledged by major processing industries the world over. Continuing expansion in the petroleum and chemical fields has created a number of openings for men with the ability and desire to work at the highest level of technical standards in solving a diversity of complex processing and operating problems, and to deal effectively with both national and international clients.

If you meet the requirements, you are invited to inquire for more information on positions open. Please address complete resume to R. L. Stacom.

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For our supervisory development program. Specific duties are assigned providing opportunity to accept responsibility and be exposed to a variety of unit operations and processing conditions.

Requirements are a Chem. Eng. degree plus 1-2 years industrial experience (supervisory not necessary) or, time in military service.

If you have a strong interest in your personal growth into management, please write in confidence to:



John W. Church, Personnel Mgr.
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U.S. based international chemical corp requires a superintendent for an alkali plant located in South America. The outstanding man we are seeking should be experienced in all phases of operating a caustic/chlorine electrolytic plant.

Education requires B.S. in chemical engineering or chemistry. Age 28-35. Salary commensurate with experience. If your background qualified you for this opportunity please send a complete resume to

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Diversified midwest corporation is establishing corporate research center. Write C. M. MacMillan.

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2 CHEMICAL PLANT SALES

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STAINLESS COLUMNS

78"x18"x1/4" Vulcan 318 S.S. Bubblecap, 14 trays, 180 caps/tray, 50 PSI.
72"x30"x1/8" Budd 347 S.S. Bubblecap, 21 trays, 38 caps/tray.
48"x41"x1/8" Vulcan 316 S.S. Bubblecap, 40 trays, 70 caps/tray, 100 PSI.
36"x21"x1/4" 316 ELC S.S. Packed, 15 PSI.
36"x20"x3/16" 316 S.S. Packed, 100 PSI.
14"x17"x6"x1/8" 316 S.S. Packed.
12"x18"x3/16" 347 S.S. Packed, 100 PSI.

COLUMNS

20"x27" GLASS LINED 50 PSI full vacuum.
16"x21" GLASS LINED Scrubber.
16"x10" GLASS LINED 25 PSI full vacuum.

REACTORS

Pfaudler 500 gal. ELL. GL. Lined Jkt. Agit.
Pfaudler 300 gal. EL. GL. Lined Jkt. Agit.
Dopp 1000 & 1700 gal. Ni-Resist Jkt. Agit.
Patterson 1000 gal. Steel Jacketed.
Patterson 500 gal. Steel Jkt. Agit. 2 HP XP.
Alloy Tank 300 & 750 gal. SS Press. Stills.

STAINLESS HEAT EXCHANGERS

2320 Sq. ft. 33"x21'-1"x16ga. x16' Tubes.
1000 Sq. ft. 27"x168'-3/4"x16ga. x14' Tubes.
890 Sq. ft. 22"x20'8"-3/4"x16ga. x14' Tubes.
800 Sq. ft. 23"x17'10"-3/4"x16ga. x16' Tubes.
615 Sq. ft. 22"x15'9"-3/4"x16ga. x10' Tubes.
420 Sq. ft. 18"x9'6"-3/4"x18ga. x8' Tubes.
300 Sq. ft. 14"x19'6"-3/4"x18ga. x12' Tubes.
235 Sq. ft. 16"x8'3"-5/8"x16ga. x7' Tubes.
188 Sq. ft. 11"x16'8"-3/8"x14ga. x12' Tubes.
146 Sq. ft. 11"x14'4"-5/8"x16ga. x9'6" Tubes.
68 Sq. ft. 8"x17'3"-3/4"x16ga. x16' Tubes.

CENTRIFUGES—FILTERS

Sharples C-27 Super-D-Hydrator Stainless.
30" Susp. Centrifuge-Imperforate Stainless.
5'3"x3" Oliver Precoat Rot. Vac. Filter SS.
4'x1" Bird Young Rot. Vac. Filter Stainless.
36"x24" Gossin Rot. Vac. Filter Stainless.
18"x28" Bird Continuous Stainless.
400 sq.ft. U.S. Auto-Jet Filter Monel Screens

COMPRESSORS—VACUUM PUMPS

Nash H-7 Vacuum Pump 270 CFM @ 26"
Nash #9 Compressors 2150 CFM @ 16 PSI.
Worthington YO 1360CFM @ 35PSI; 150 HP.
Norwalk Hydrogen Comp 5 CFM 15000 PSI.
Nash #4 Vacuum Pump 650 CFM @ 15".
Nash L-3 Vacuum Pump SS 130CFM @ 20"

STAINLESS STEEL TANKS

11500 gal. 12"x15"x16 agitated.
4500 gal. 6'x25"x1/4" dish cone 25 PSI coil
4000 gal. 8'x12'x3/16" dish Coiled.
3500 gal. 8'x9'x5/16" dish heads.
1500 gal. 6'x6'9"x1/4" dish heads.
1200 gal. 5'x8'x1/4" Agitated.
750 gal. 4'6"x6'x1/4" dish 42 PSI.
500 gal. 4'x5'x5/16" dish heads.
500 gal. 4'x5'6"x1/4" Rat Agitated.
(20) Tanks 50 to 400 gal. some agitated.

SPECIAL ITEMS

TRIPLEX PUMP—21/4x4 Stainless 2000 PSI.
CRYSTALLIZER Squire 40"x30" Agit. Jkt.
CRYSTALLIZER Builovak 6' Vac. Jkt. Agit.
CRYSTALLIZER Swenson 24"x20" Jkt. SS
AIR DEHYDRATOR-Anders 8FA Automatic.
ABSORPTIVE DRYER-Kemp FE02-S.
SIFTERS 30"x36"; 40"x34"; 60"x34" SS
SIFTER 48" Sweco Triple Deck Model A9062
CONVERTER-St. Wells 10"x29" 10000 sq. ft.
HEATER 150KW Hot Oil Hynes Elec. Co.
MIKER 300 gal. B.P. Stainless Sig. 18 DIM.
BLENDER Conical 6" Patterson 68CF 10 HP.
EVAPORATOR-435 Sq. ft. Single Effect.
CENTRIFUGAL PUMPS-STAINLESS-1" to 3"
10 to 750 GPM 35 to 100' Head

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CIRCLE A ON READER SERVICE CARD

Equipment Searchlight

CE's Searchlight spots the big bargains in used, resale and rental equipment.

Check this issue's listings—most complete in the field—for items you need now.

STRETCH YOUR \$\$\$\$ at M&E

3—Eimco 4' x 6' stain. rotary cont. vac filters. Vari speed dr.

2—Oliver 5'3" x 6' stain Precoat rotary cont vac Filters. Comp variable speed drive.

1—Eimco 6' x 8' stain rotary cont vac Filter. Vari speed dr.

2—Sweetland #12 Filters. 48 bot drain lvs. Vert. sight glasses. Motor driven sluicing.

1—Swenson steel body Evaporator. 660-2" tubes 5' long. Comp.

1—New Kelly SS long tube Evaporator. 751-1" OD 12 ga tubes 15' long.

1—Sepore hydr Laminating Press. 250 ton 8 open. steam heated 34" x 38" platens. Complete.

1—Louisville 54" x 35' long rot Monel steam tube Dryer. 1100 sq ft. Code. 150# WP.



MACHINERY AND EQUIPMENT CO., INC.
123 TOWNSEND ST. - SAN FRANCISCO 7, CALIFORNIA

CIRCLE B ON READER SERVICE CARD

BEST VALUES

Evaporator: Builovak dbl. eff. st.st. 845 sq. ft.
Evaporator: Builovak dbl. eff. st.st. 608 sq. ft.
Evaporator: Mojonnier dbl. eff. st.st. 1250 sq. ft.
Evaporator: Builovak sgl. eff. st.st. 67 sq. ft.
Evaporator: Swenson four eff. C. 1. 5700 sq. ft.
Dryers: Double Drum, 42 x 90; 32 x 100 Builovak.
Dryer: Double Drum, 42 x 120 American.
Dryer: Rotary Steamtube, Louisville 6' x 28' (2).
Twin Shell Blender, Patterson-Kelly, 30 cu. ft. S.S.
T304, 7 1/2 H.P. drive.
Centrifuges Tolhurst 40" and 26" Suspended perf.
Centrifuges: Bird continuous, 18 x 28, S.S. T316.
Filter, Rotary Vacuum with pressure housing, Dorr
Oliver 5'3" dia. x 4' face (2).
Tanks: 2300 (2)—1500 gal. Vertical St.St.
Tanks: 3000 (2)—1500—300 gal. vertical St.St. for vacuum, with coils.
Kettles: (2) 600 gal. agitated st.st.; with 15 P.S.I. steel jacket.

BEST EQUIPMENT COMPANY
1737 W. HOWARD ST. CHICAGO 26, ILL.
Ambassador 2-1452.

CIRCLE F ON READER SERVICE CARD

RAYMOND FLASH DRYING SYSTEM

Complete—Unused
LINK BELT ROTO LOUVRE DRYERS, 6'x24' 316 S/S
SPRAY DRYERS 5/S. PRODUCTION & LAB.
SEND US YOUR INQUIRIES
N. J. SNOW EQUIPMENT CO.
1700 Helcombe Houston 25, Texas JA 2-0359
507 Fifth Ave. New York City OX 7-5895

CIRCLE G ON READER SERVICE CARD

SPECIAL OFFERINGS

1—T316 Stainless Autoclave 30 Gal. 1000 psi
1—Kent 13" x 32" High Speed 3 Roll Mill
2—Day 40 Gal. Pony Mixers—SS & Steel
1—Day 2000 S.S. Horiz. Blender
3—Day Size F & C Horiz. Blenders
1—Patterson Gyro Sifter SS 20" x 40"
3—Rotox Screens 30" x 96" to 60" x 84"
3—Hercules T316 SS Sifters 8" x 8"
3—Nash Hytor TS-10 Vac. Pumps 118 cfm
3—Stokes 2125 Vac. Pumps 130 cfm
1—BP Double Arm Mixer 100 Gals.
4—S.S. Tanks 600 to 6000 Gals.
1—Charlotte T316 Colloid Mill 600 gph

Send for Bulletin A46 for complete listings. We buy your Surplus. Send us your lists.

The Machinery & Equipment Co.
Used Div.
Newark 5, N. J. Market 2-3103

CIRCLE H ON READER SERVICE CARD

1800 HP WESTINGHOUSE GAS TURBINE

driving two
CLARK CENTRIFUGAL COMPRESSORS
2 compressors in tandem, Model 2MS, 7000 CFM AIR, 100 PSIA
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CIRCLE J ON READER SERVICE CARD

HOW to LOCATE EQUIPMENT

without cost or obligation

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Send us the specifications of the equipment wanted and you will receive an immediate reply with full details.

EQUIPMENT FINDERS BUREAU

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Class. Adv. Div., P. O. Box 12, N. Y. 36, N. Y.

CIRCLE C ON READER SERVICE CARD

Dowtherm 225 KW
Autoclave S.S.—50 gal.—2000 lb. pres.
Autoclave S.S.—3 1/2 gal.—2000 lb. pres.
Proctor & Schwartz finned drum drier
Centrifuge S.S. 26"—Tolhurst
2 Evaporating Dishes—jacketed S.S. 71" dia.
1 Kettle S.S.—jacketed—500 gal.
2 Kettles S.S. Jacketed—agitated—250 gal.

MACHINECRAFT CORPORATION

800 Wilson Ave. (East of Doramus)
Newark 5, N. J. MI 2-7634

CIRCLE D ON READER SERVICE CARD

Hersey 5'x26' Rotary S.S. Dryer
Buffalo 32"x90" Double Drum Dryer
Day Hy-R Speed Mill 20 HP XP

SEND FOR LISTINGS

STEIN EQUIPMENT CO.

107—8th Street Sterling & 1944 Brooklyn 15, N. Y.

CIRCLE E ON READER SERVICE CARD

LIQUIDATIONS

CLEVELAND, OHIO

1—Raymond #73612 Super High Side 6-Roll Mill, with whizzer, cyclone, piping and motors.

1—Raymond #6669 Super High Side 6-Roll Mill, with whizzer, cyclone, piping and motors.

1—Raymond #5047 High Side 4-Roll Mill, with whizzer, cyclone and piping

1—#1 Raymond Impact Mill, with whizzer, cyclone and piping.

1—Raymond 12' dia. Double Whizzer Air Separator.

2—Sturtevant 14' dia. Air Separators.

1—Kilby Nickel Single Effect Force Feed Evaporators, 1200 sq. ft.

2—12,000 gal. Nickel Clad Tanks.

2—Oliver 5'3"x4' Nickel Clad Rotary Vacuum Filters.

2—Pfaudler 300 and 200 gal. Glass Lined Jkt. Agt. Reactors.

1—Sperry 30" C.I. Filter Press, 27 chambers.

1—Buřlovak 32"x90" Dble Drum Dryer.

4—Feinc 8'x12' Rotary Vacuum Steel Filters, string discharge.

2—Peabody Gas Scrubbers stainless steel 11,000 CFM and 6,000 CFM at 145°F with fans, motors.

2—6'6" dia. x 60' Rotary Dryers.

1—5½'x4½'x50' Rotary Dryer.

1—5½'x4½'x60' Rotary Dryer.

7—Dorr 80' and 40' thickeners.

3—Vogt 387 sq. ft. Rotary Press. Filters.

2—Chicago Pneumatic 26"x14" Vacuum Pumps with 150 HP motors.

3—Fuller Kinyon Pumps H5 and H6.

1—Link-Belt 24"x90' Belt Conveyor

5—Nickel Centrif. Pumps, 2", 3".

GENEVA, NEW YORK

2—Vulcan 3'x20' 347 S.S. Packed Columns with 240 sq. ft. S.S. Heat Exchanger.

5—S.S. Condensers 70 to 250 sq. ft.

6—Nash H5, L5 Vac. Pumps 20 & 15 HP.

1—Nash L3 Stainless Vacuum Pump.

6—1,200, 1,000 & 400 gal. 347 S.S. tanks

8—25,000 gal. Aluminum Storage Tanks, ½" shell.

2—3000 gal. Aluminum Tanks, 7'x11'.

1—Tolhurst 40" Centrifuge 347 S.S. imperforate basket, 15 HP.

1—Swenson Vert. 347 S.S. Single Effect Evap. 300 sq. ft.

2—Banks S.S. cooling coils, each bank having 24—2" tubes 20' long.

BRILL FOR VALUES

CENTRIFUGES

3—Bird 18" x 28", 24" x 38" Solid Bowl Continuous 304 S.S.

1—Bird 40" x 60" Solid Bowl Continuous 316 S.S. UNUSED.

5—Sharples C-20 and C-27 Super-D-Hydrotator 316 S.S.

3—Sharples PY 14, PN14 Super-D-Canters 316 S.S.

2—Sharples #16, 304 S.S., 3 HP motor.

1—Tolhurst 40" 347 S.S. imperforate basket 15 HP UNUSED.

TANKS

25—500 to 3500 gal. Vertical 304 S.S. Tanks opened and closed, some agitated.

6—7500, 6000 and 2000 gal. Rubber Lined Tanks.

1—1500 gal. Stainless Pressure Tank, 5' x 10', 90#.

1—2000 gal. Horizontal 304 S.S. Tank 5' x 12'.

1—2500 gal. Vertical 304 S.S. Tank 8' x 7'.

1—10,000 gal. Rubber Lined Tank 10' x 17'6".

1—5500 gal. 316 S.S. Clad Pressure Tank 250 PSI.

1—12,000 gal. Horizontal Steel Pressure Tank 7'6" x 36", 200 PSI.

5—25,000 gal. Aluminum Storage Tanks.

REACTORS—EVAPS—CONDS—COLUMNS

1—Pfaudler 125 gal. 304 S.S. Jacketed Agitated Reactor 150# int., 125# jacket.

3—Pfaudler 200 gal. glass lined jacketed Kettles.

2—Pfaudler 850 and 650 gal. Steel Jacketed, Agitated Reactors.

1—650 gal. 304 S.S. Reactor with 100 sq. ft. Bayonet Heater.

1—O. G. Kelly 3000 sq. ft. 309 S.S. force feed Evaporator UNUSED.

1—550 sq. ft. Buřlovak monel single effect Evaporator.

1—250 sq. ft. Buřlovak 304 S.S. Single Effect Evaporator.

10—Stainless Heat Exchangers; 910, 536, 370, 250, 131, 70 sq. ft.

1—4'6" x 46' 316 S.S. Clad Column, 250 PSI.

6—30" x 19' S.S. Packed Columns.

1—24" x 35' 304 S.S. Bubble Cap Column.

FILTERS

2—Niagara 110 sq. ft. Vert. 316 S.S.

1—Niagara 92 sq. ft. Vert. Jkt. 316 S.S.

2—#10 Sweetland, 27 leaves 4" centers

1—#5 Sweetland 304 S.S., 120 sq. ft.

1—Oliver 6' dia. Horizontal 316 S.S.

1—Oliver 4' dia. Monel Horizontal.

1—U.S. 200 sq. ft. 304 S.S. Auto-Jet.

1—Hercules 400 sq. ft. 304 S.S. Pressure.

3—Oliver Precoat 5' x 6', 5' x 10', 8' x 10'.

1—Oliver 5'3" x 8' Steel Rotary Vac housing.

1—Feinc 3' x 1' 316 S.S. Rotary Vac.

DRYERS

1—Buřlovak Vacuum Shelf, 17—60" x 80" shelves.

2—Buřlovak 42" x 120", atmospheric double drum complete.

1—Buřlovak 32" x 90" Atmos. Twin Drum.

2—Devine 4' x 9' single drum, atmospheric.

1—Buřlovak 3' x 10' Rotary Vacuum.

6—Louisville Rotary Steam Tube 5' x 6', 6' x 30', 6' x 50'.

2—Louisville 8' x 50' Stainless Steel lined Rotary.

3—Rotary Dryers 4' x 40', 6' x 50', 6' x 60', 7' x 80', 8' x 87".

1—Louisville 4½' x 25' Inconel Rotary.

1—Link Belt 6'4" x 24' Roto Louvre 316 S.S.

1—Stokes model 38-A Tray Dryer with 16—36" x 36" S.S. Shelves.

2—Atmos. Tray, 16 shelves, 40"x24".

2—10' and 4' dia. 304 S.S. Spray Dryers.

2—Wyssmont, 304 S.S. 6'2" and 9'6" dia.

MIXERS

1—Sturtevant 75 cu. ft. 304 S.S. Rotary Batch Blender 20 HP.

1—Abbe 110 gal. 304 S.S. Jacketed Agitated Vacuum Dispersall Mixer.

2—Day Imperial 150 gal. jkt'd. double arm.

2—Baker Perkins 150 and 100 gal. jacketed double arm Sigma blades.

1—Baker Perkins 50 gal. jacketed.

5—Day "Cincinnati" double arm, 250 and 100 gal.

2—Steel jacketed Powder Mixers, 225 and 350 cu. ft.

1—1500# Powder Mixer 304 S.S.

1—3' dia. Simpson Intensive Mixer.

1—45" dia. Lancaster Mixer 7½ HP motor.

1—Patterson 80 cu. ft. Conical Blender, 304 S.S.

MISCELLANEOUS

3—Kinney Vacuum Pumps, 1000 cfm, 10 microns, 15 HP.

2—Hardinge 5' x 22" steel lined conical Ball Mills.

3—Mikro Pulverizers, 1SH, 1SI and Bantam.

3—Abbe 2½" x 3' porcelain lined Pebble Mill XP motor.

1—Raymond 10" vert. Mill, 10 HP.

3—Swenson Walker Continuous Crystallizers, 24" x 30' sections.

2—#24 Rotex Sifters 20" x 64", 40" x 56".

5—Day Roball Sifters, 40" x 120", 40" x 84", Double Deck.

6—Nash H6, H5, H3 Vacuum Pumps.

3—Nash H6, 347 S.S. Vacuum Pumps.

4—Stokes Rotary Tablet Machines DD2—DDS2—DS3—RB2.

Partial List of Values—Send for Complete Circular

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CIRCLE K ON READER SERVICE CARD

MULTI-MILLION DOLLAR LIQUIDATION

NORTH LITTLE ROCK, ARK.

STAINLESS STEEL TANKS

13,300 gal., 11'10" x 15'7", cone top.
12,000 gal., 11'6" x 15'6", cone top.
3650 gal., 10' x 7', open top.
3000 gal., 5' x 19', T347SS, ASME
60 psi, dished heads.
1350 gal., 4'x14', T347SS, ASME 60
psi, dished heads, int. coils.
1300 gal., 7' x 4'6", T321SS, closed
1100 gal., 4' x 11', T347SS, ASME
60 psi, 3/16" shell, 1/4" heads.
476 gal., 4'6" x 4', open top.
475 gal., 5'6"x2'6", open top.
445 gal., 6'x2', open top.
300 gal., 4'x3', T347SS, ASME 60
psi, dished heads.
285 gal., 41"x49", open top.
260 gal., 40"x48", closed top.

GLASS-LINED TANKS

Pfaudler 11,500 gal. horiz. blue
glass-lined tanks, 8' x 30', 1/2" shell,
7/16" dished heads, 20 psi. With
75 sq. ft. nickel coil, Aurora St. St.
sump pump.

STEEL PRESSURE TANKS

28,000 gal. 11' x 38', dished, ASME
75 psi.
28,000 gal. 11' x 38', lead-lined.
14,000 gal., 8' x 36', dished.
11,000 gal., 8' x 27', dished, ASME
300 psi.
9000 gal., 8' x 23', dished.
5200 gal., 6' x 24', dished, 60 psi.
3300 gal., 6' x 15'6", dished, ASME
125 psi.

BOILERS

3—3000 CFM Edgemoor waste-heat
boilers, 250 psi, 535 sq. ft., ASME.
5—435 HP Comb. Eng. water-tube
boilers, 300 psi, 4620 sq. ft.,
34,500 lb. steam/hr. @ 225%
of rating, gas or oil fired.

COMPRESSORS—BLOWERS

Worth 3500 CFM air comp., 24 x 15,
#LTC-4, 500 HP gas driven.
Chicago-Pneu. 3026 CFM air comp.,
size #19-32-30-18 x 24, horiz.
steam driven.
Elliott turbo-blowers, 11,620 CFM,
type 0, 15.9 psi discharge, 125 HP.
Ing.-Rand 6 x 6 x 5 air comp.,
V-type, 2 cyl, #67D9, type 30.

KETTLES—REACTORS

1400 gal. Pfaudler blue glass-lined
jacketed kettles, 84" dia. x 54"
high, open top, Stainless Steel cover,
3 HP Agit., Adj. baffle.
1250 gal. Pfaudler blue glass-lined
jkt. reactors (Sulphonators), 72" dia.
x 72" high, closed, 3 HP Agit.
600 gal. Pfaudler Stainless Steel
ammoniating & crystallizing jkt.
kettles, 60" dia. x 46" high, open.
250 gal. Pfaudler blue glass-lined
jacketed kettles, 42" dia. x 36"
high, open top, Stainless Steel cover.

STAINLESS PUMPS

Worthington Worthite Cent. Pumps;
4" x 3", 3" x 2", 2" x 1 1/2", 1 1/4"
x 1", w/motors.
LaBout 2" 316 SS self-priming cent.
pumps.

COLUMNS—HEAT EXCHANGERS

24" dia. x 15' high Duriron packed
columns.
24" dia. x 33' high Duriron & St. St.
packed column.
24" dia. x 4' high Duriron vacuum
denitrating columns.
1450 sq. ft. T347SS gas condensers,
3-pass Vert. units.
1000 sq. ft. Duriron pipe coolers.
564 sq. ft. Stainless Steel burner-
Preheaters, gas condensers, 3-pass.
400 sq. ft. Stainless Steel open-pipe
coolers, 2 3/8" OD pipe.
Amer. spiral heat exchangers T3161
S/S: 162, 72 sq. ft.
Duriron pipe coolers, 159, 130, 125,
99, 54, 44, 42, 10 sq. ft.
18 sq. ft. Ammonia evaporators.

SEND FOR
DETAILED
CIRCULAR!

PERRY

EQUIPMENT CORP.
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Phone POplar 3-3505

CIRCLE L ON READER SERVICE CARD

MODERN REBUILT MACHINERY



Baker Perkins, Day, W & P Heavy Duty Mixers,
5 to 150 gal. cap..
Colton models 241 and 260 Double Rotary
late style Tablet Presses.
J. H. Day Dry Powder Mixers, 50 to 1000 lbs.
Roiey, Day Sifters 20 x 48, 20 x 80, 40 x 120.
WRAPPERS: Package Machinery, Hayssen,
Hudson Sharp, Battle Creek, Scandia,
Wrap-King, all sizes and models.
Pneumatic Scale High Speed Automatic Car-
toning Line with Feeder, Bottom Sealer, Top
Sealer, Wax Liner, Interconnecting conveyors.
Stokes & Smith Models G1, G2, HG84, HG87
and HG88 Auger Powder Fillers.
Colton 6' diam. Stainless Steel Revolving Pan.
Fletcher 30" Stainless Steel Basket Centrifuge.
Raymond Model "O" Pulverizer.
Mikro 2DH Stainless Steel Pulverizer.
Mikro No. 6 S.S. Atomizer and Bantom, 15H,
2TH, 3TH, and 4TH Pulverizers.
Fitzpatrick KB Stainless Steel Comminuter.

Complete Details and Quotations On Request

UNION STANDARD EQUIPMENT CO.

318-322 Lafayette St. 167 No. May St.
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CAnal 6-5333 SEely 3-7845

CIRCLE M ON READER SERVICE CARD

NEW FILTER, stainless steel NIAGARA
48" dia. w/510 sq. ft.

NEW GRANULATOR #24, Stokes oscil-
lating, S/S, also used 43A, S/S

NEW VOTATOR, S/S, lab. model, 4 speed
FURNACE, electric, 5"x12"x30"
muffle, 1600°C, Globar, w/50KVA
transformer

MIKRO PULVERIZERS, 2 model 2TH w/
10HP motors & vari-drive feeds

OVEN, Truck/Tray, 650° F. electric,
5'X6'6"X14", self-contained package
unit.

LAWLER COMPANY

Durham Ave. Liberty 9-0245 Metuchen, N. J.

CIRCLE N ON READER SERVICE CARD

ECONOMIZE DOLLARWISE

ROTARY PILOT KILN

Brick lined 25" x 15' long skid mounted
with firing head, end enclosures and
discharge spout. Variable speed motor
& drive.

Excellent Condition



**MACHINERY AND
EQUIPMENT CO., INC.**

123 Townsend St. - San Francisco 7, Calif.

CIRCLE O ON READER SERVICE CARD

- (2) 700 HP York Brine Chilling Units
- (2) 100 HP Carrier Chilling Units
- (1) 10 x 10 Frick Ammonia Compressor,
125 HP
- (2) 9x9 York, 75 HP

JOHN F. CARSON
A & VENANGO STS. PHILA. 34, PA.
GARfield 6-2221

CIRCLE P ON READER SERVICE CARD

SUMMER FEATURES

- 1—Bird 18" x 28", T304 SS conical bowl.
- 1—Symons 2' shorthead cone crusher.
- 2—Vulcan 78" dia. x 35 plate copper bubble-cap distillation columns.
- 1—600 gal. Stainless jacketed kettle, 72" dia.
- 1—Bonnot 5' x 10' contin. ball mill, 75 HP.
- 1—6' x 150' rotary kiln, 3/8" welded.
- 1—Raymond 66", 6-roll hi-side mill.
- 2—800 sq. ft. T316 SS exchangers.
- 1—Link-Belt #900-30 Roto-Louvre.
- 3—20,000 gal. T316LC SS crystallizer tanks, 14' x 15', cone bottom, 3/8".
- 2—T316LC SS tanks: 3250, 2250 gal.
- 1—Buřovak 588 sq. ft. T304 SS Dbl. effect evap., long-tube.
- 2—Louisville 4'-6" x 25' steam-tube dryers.
- 5—Sharples C-20 & C-27 super-D-hydrators, T316 SS, motor, timers.

DRYERS—KILNS

- 2—Buřovak 42" x 120" double drum dryers, ASME 160# WP.
- 1—American 42" x 120" dbl. drum.
- 1—Buřovak 42" x 90" dbl. drum.
- 1—Buřovak 32" x 72" twin drum dryer, chrome plated drums, St. St. trim.
- 2—American 36" x 84" Dbl. Drum.
- 1—Buřovak 32" x 52" Dbl. Drum.
- 1—American 36" x 84" double drum dryer, ASME, VACUUM.
- 1—Buřovak 5' x 12', single drum dryer, Vacuum UNUSED.
- 5—F. J. Stokes #138J-16, 195 sq. ft. vac. shelf dryers.
- 1—Nerco-Niro stainless spray dryer.
- 1—Vulcan 10' x 11' x 175' rotary kiln.
- 2—10' x 78' rot. dryers, 3/4".
- 2—Davenport 8' x 60' rotary, 7/16" welded burners, fans, etc.
- 1—7'-6" x 62' rotary kiln, 1/2".
- 2—Louisville 4'-6" x 25' rotary steam-tube dryers, welded.
- 1—Bartlett & Snow 3' x 15' rotary dryer, Everdur metal shell.

PRESSES

- 3—Komarek-Greaves 160,000 psi briquette presses.
- 4—Davenport dewatering presses; #1A, 2A, 3A.
- 1—Stokes #T single-punch tab. pres.
- 1—Stokes #RD-3 rotary tablet press.
- 1—HPM 63 ton steeping press, UNUSED.

PERRY FOR PROCESS EQUIPMENT

EVAP.—STILLS COLUMNS—CONDENSERS

- 7—4050 sq. ft. calandra type evap., copper tubes, cast iron shell.
- 1—Mojonnier 2085 sq. ft. triple-effect Stainless Sanitary evaporator.
- 4—Buřovak double-effect stainless evap. vert. long-tube type: 1025, 840, 710, 588 sq. ft.
- 1—Stokes 118 sq. ft. T316SS Still.
- 1—Vulcan 110" dia. x 16' high T316SS bubble-cap column, 10 trays.
- 2—78" dia. x 35' plate copper columns.
- 1—Vulcan 60" dia. x 16' high, T316SS bubble-cap column, 10 trays.
- 6—30" x 19' T347 SS packed columns.
- 15—Copper bubble-cap columns, 24" to 54" dia. to 51' high.
- 1—1960 sq. ft. T316SS exchanger remov. bundle, ASME 75# WP.
- 1—1450 sq. ft. T316SS condenser.
- 5—1400 sq. ft. T316 SS gas converters.
- 1—915 sq. ft. T304 SS exchanger.
- 3—800 sq. ft. T316SS condensers.
- 1—730 sq. ft. T316 SS exchanger.
- 1—510 sq. ft. T316SS condenser.
- 30—T316 SS heat exchangers & condensers: 425, 410, 400, 290, 277, 200, 186, 165, 150, 142, 105, 83, 73, 54, 50, 30 sq. ft.

MIXERS—MILLS

- 40—Baker-Perkins #17, 200 gal. sigma-blade, jkt. mixers.
- 1—Baker-Perkins #15, 100 gal. Disp., T347SS 25 HP drive.
- 1—Baker-Perkins #15-UUMM, 100 gal., Disp. blade, ASME jkt., 100 HP, Comp. Cover, motorized tilt.
- 1—J. H. Day #6, 100 gal., St. St. sigma.
- 2—J. H. Day #5, 75 gal., sigma.
- 1—Raymond 66", 6-roller mill, 200 HP.
- 1—Raymond 66", 6-roll hi-side mill.
- 13—Abbe 6' x 8' patch pebble mills.
- 2—Hardinge 7' x 36" conical mills.
- 1—Gemco 60 cu. ft. T304SS conical blender.
- 1—Bonnot 5' x 10' ball mill.

STAINLESS STEEL TANKS (T304 UNLESS NOTED)

- 1—13,300 gal., 11'-10" x 15'-7", vert., closed.

- 2—12,000 gal., 11'-6" x 15'-6", vert., closed.
- 5—3650 gal., 10' x 7', vert., open.
- 1—3350 gal., 8' x 8'-6", Agit., 50 psi.
- 1—3300 gal., 6' x 14'-6", vert., closed.
- 3—3000 gal., 5' x 19', T347, ASME 60 psi.
- 1—2700 gal., 7'-6" x 7'-6", closed, coils, agit.
- 2—2600 gal., 7' x 8', T316, dished, coils.
- 5—2100 gal., 8' x 5'-6", dished, coils, agit.
- 1—2100 gal., 6' x 9', T316, cone bottom.
- 12—1750 gal., hoppers, 4'-5" x 7'-4" x 9'-2".
- 4—1350 gal., 4' x 14', T347, dished, ASME 60 psi coils.
- 5—1350 gal., 7' x 4'-6", T321, closed.
- 1—1300 gal., 6' x 6', 3/8", dished.
- 3—1100 gal., 4' x 11', T347, ASME 60 psi.
- 3—1000 gal., 4'-6" x 8'-6", dished.
- 3—850 gal., 4' x 9', 3/8", dished.
- 1—800 gal., 5' x 5'-6", 1/4", dished.
- 3—750 gal., 5' x 5', 3/16", dished.
- 6—685 gal., 3' x 13', T316, coils.
- 1—400 gal., 4' x 4', 3/16", dished.
- 3—300 gal., 4' x 3', T347, ASME 60 psi.

PARTIAL LIST

SEND FOR COMPLETE LIST!

KETTLES—REACTORS

- 1—2000 gal. Glascote blue G/L reactor, ASME 50 psi or vac. int., 90 psi jkt.
- 3—1350 gal. T347SS Kettles, open top, paddle agitators.
- 1—1000 gal., T316 SS jacketed reactor, ASME, UNUSED.
- 1—1000 gal. Dopp cast iron Kettle, 125# jacket, 15# int., Agit.
- 1—750 gal. Graver T304SS jkt. fermenter, ASME 30# int., 30# jkt., 10 HP Turbine Agit.
- 2—600 gal. T304SS reactors, Jkt., Agit.
- 2—500 gal. T304SS reactors, jacketed, ASME, Vacuum—Unused.
- 6—465 gal. T304LSS reactors, jacketed, 150# int., 175# jkt.
- 1—300 gal. Pfaudler blue G/L reactor, Agit., Jkt., ASME.
- 1—300 gal. Glascote blue G/L reactor.
- 1—200 gal. T304SS jkt. reactor.

PERRY

EQUIPMENT CORPORATION

1413-21 N. SIXTH ST. PHILADELPHIA 22, PA.
Phone POplar 3-3505



CIRCLE Q ON READER SERVICE CARD

**DON'T LET
GOOD EQUIPMENT
SLIP THRU YOUR
FINGERS!**

SPECIAL OFFERING DIRECT FROM LOCATION CONTINUOUS FINE GRINDING EQUIPMENT

Being Removed as
Operations Terminate

- 2—Allis Chalmers 7'x22' (2 Compartment) Compeb Ball Mills with Meehanite Liners, driven by a magnetic-coupled 400 HP Motor.
- 1—Allis Chalmers 9½x810 Preliminary of Continuous Ball Mill; Meehanite Liners, driven by a magnetic-coupled 400 HP Motor.
- 3—Allis Chalmers 7'x22' Continuous Ball Tube Mills, with Meehanite Liners, each driven by a magnetic-coupled 400 HP Motor, now operating in closed circuit with
- 3—Raymond 14 ft. Double Whizzer Mechanical Air Separators, New in 1950, each driven by 75 HP Motor. May be purchased separately. Send for Prices and Details.

MIXERS FOR EVERY PURPOSE

Brand NEW FALCON Ribbon Blenders; all sizes now in Stock; S.S. or Mild Steel.
Baker Perkins Heavy Duty Jacketed Mixers; from 5 gal. to 300 gal.
J. H. Day Mogul Mixer, 150 gal. Vac. Cover; 75 HP.
Day Cincinnati Double ARM Jacketed Mixers, 75, 200, 300 gal.

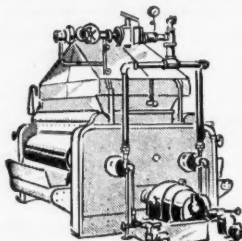
REACTORS and PRESSURE VESSELS

Struthers Wells 2000 Gal. Stainless Reactors; Jkt. and Agtd.
2 Stainless 400 Gal. Reactors Jkt. & Agtd. by Struthers Wells.
6 Dorr-Oliver 550 gal. Stainless Thickeners or Reactors.
Pfaudler Glass Lined Reactors, Jacketed, Agitated from 50 Gal. to 500 Gal.

MILLS—GRINDERS—PULVERIZERS

Mikro Pulverizers up to No. 4; Mikro S/S Atomers No. 5 and No. 6.
Fitzpatrick Commutating Machines, in Stainless; Models M, D and K.
Abbe Jacketed Steel Ball Mill; 42' x 32'; with charge of balls.
International Porcelain Lined Pebble Mills; 8' x 8'; 50 HP gearmotors.

SAVE \$8000 on this BUFLOVAK DRYER



Buflovak Type F-3-C DOUBLE DRUM DRYER 42"x100" ASME 100# W.P. complete with Stainless Hood and all accessories.

FMC PAYS MORE FOR YOUR SURPLUS EQUIPMENT

CENTRIFUGES—CLARIFIERS

Stainless Suspended Type Centrifugals from 30" to 60".
2 Sharpless Stainless Steel Model PN14 Super-D-Centers.
Sharpless C-27 Super-D-Hydrator in Type 316 Stainless; 40 HP.
2 Bird Continuous Horizontal Centrifuges; S/S & Manel 24".
2 Bird Rubber Covered Fume-Tight 48"; with Plows; 40 HP.

DRYERS—EVAPORATORS

Devine Dbl. Door No. 36 Shelf Dryer; (20) Shelves, 86" x 78".
Louisville MONEL Rotary Steam Tube Dryer; 54' x 35".
2 S/S Acme Continuous Rot. Vacuum Dryer or Concentrators.
Double Drum Dryers of Standard Make; 28" x 60" to 42" x 120".
2 F. J. Stokes Vacuum Impregnating Systems; complete.
Bowen Stainless Steel Table Model Spray Dryer; 30" x 32".
Bartlett-Snow Jkt. Agtd. Batch Dryer; 6' Dia.; 49 cu. ft.
Zaremba Double Effect INCONEL Evaporator with Calandria.
Buflovak S/S Sanitary Thermo-Recompression Evaporator Complete.

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LOCOMOTIVES—RR CARS & CRANES
9 Gen. Elec. 20, 25, 45, 65, 70, 80, 100, 125 Ton
25-Ton Industrial Brownhoist 60' Boom Crane
200—50 Ton Box 300—70 Ton Gondola Cars
300—1½, 5, 20 & 30 yd Dump Cars

PLANT EQUIPMENT
2—Wemco 2M-HMS Plants
No. 1 Sturtevant Hammer Bar Mill
No. 2 Robins Vertical Cone Crusher
24" x 24" Jeffrey Single Roll Crusher
No. 1 Sturtevant Rotary Fine Reduction Crusher
F58 Syntron Grizzly Feeder
5' x 8' & 4½' x 9' KVS Air Sweet Ball Type Mills
Bail Mills: No. 56, 5' x 5', 6' x 4', & 7' x 22'
Hardinge Mills: 3' x 8', 5' x 22' & 8' x 22'
Rod Mills: 4' x 11', 6' x 12' & 7' x 15'
Jaw Crushers: 8' x 10", 9' x 24", 10' x 30",
12' x 26", 13' x 24", 14' x 28", 18' x 36", 30' x 36", 66' x 84"
Crushers, Fine Reduction: 22", 2', 3', 4', 5½' & 7'
636 & 436 Allis Chalmers Hydrocone Crushers
Crushers Roll: 24" x 14", 30" x 14", 40" x 18"
Rotary Dryers: 5' x 30', 6' x 50', 6' x 70' & 8' x 80'
Rotary Kilns: 6' x 70', 7' x 110' & 9' x 160'
2—43" x 120" Buflovak Atmos Double Drum Dryer
Roto Louvre #207-10 Type 316 S.S. Link Belt
150—1½, 2 & 4 yd & 30 yd Dump Cars
5 & 10 HP LB Car Pullers
3' x 12' Seco Single Deck Vibrating Screen
16' Gayco Centrifugal Air Separators
BX-100 Sutton Steele & Steele Air Table NEW
6—30" x 32" Dings Magnetic Head Pulpies
690', 2200', 3068' & 3600-7500' I.R. Compressors
4100 CFM Sly Dust Collector

WANT BUY DRYERS—KILNS—CRUSHERS
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Tel. MU 2-3075 or MU 2-1898

CIRCLE S ON READER SERVICE CARD

COMPRESSORS

No better values at any price

72 CFM 1500 PSI 6½-3½-1½x7 CP
80 CFM 3500 PSI 6½-4-1 7/16x9 IR ES3
138 CFM 100 PSI 7x7, Ing. ES, CP & Joy
258 CFM 500 PSI 9½x14x11 Ing. ES2 New
288 CFM 100 PSI 9x9 Ing. Worth, CP
311 CFM 1500 PSI 10½x7½-3½-13 IR-ES3
465 CFM 100 PSI 12x11-IR-ES C.P.T. Worth HB
502 CFM 125 PSI 12x13 Worth HB
586 CFM 110 PSI 15-9½x12 Ing. XRE
686 CFM 100 PSI 14x13 Ing. ES
805 CFM 125 CFM 17-10x12 CP oee
1050 CFM 60 PSI 13-13x12 IR-XRE
1652 CFM 110 PSI 23-14x14 Ing. XRE
300 HP GE Syn 3-60-440 (2) 1952
2200 CFM 100 PSI 26-15x28 Ch. Pn. oee 350-HP
3-6-4160-1600, 3 PF
2610 CFM 45 PSI 20-20x14 Ing XRE 25½ HP Syn.

AMERICAN AIR COMPRESSOR CORP.
Chem. Road, North Bergen, N.J. UNION 5-1397

CIRCLE T ON READER SERVICE CARD

SPECIALS

Kettles: 60 gal. st. steel agit. ASME.
Mill: Day Hisped Model B 14x30" 3-Roll.
Column: 24" x 22", 316 stain. steel.
Pebble Mills: Abbe #3, #6, and others.
Dryer: American 24x48" dbl. drum.
Dryer: Bowen lab. spray, st. st.
Evaporator: Buflovak sgl. eff. st. st. 94 sq. ft.
Dryer: Porter 2 x 4' vac. drum, st. st.
Centrifugal: Tolhurst 26" rubber, 2-speed.
Filter: Sweetland #3 st. lined.
Filter: Eimco, drum 18" x 12".
Vacuum Pans: 42" and 72" stain. steel.
Dryer: Proctor & Schwartz 6-tray st. st.
Centrifugal: AT & M 60" st. st. perf.

Write us or call Seeley 8-1431

Send us a list of your idle machines

LOEB EQUIPMENT SUPPLY CO.

820 W. Superior St., Chicago 22, Ill.

CIRCLE U ON READER SERVICE CARD

ECH SPECIAL

J. H. Day #40 Imperial Jkt. Double Arm
Mixer 300 gal. cap., 40 HP Exp. pl. mtr.
SOuth 8-4451-4452-8782

EQUIPMENT CLEARING HOUSE, INC.

111 33 Street Brooklyn 32, N. Y.

CIRCLE V ON READER SERVICE CARD

BEST BUY

STAINLESS SIGMA MIXER

Baker-Perkins Size 14 working capacity
50 gallons. Heavy cored sigma blades,
code jacket for 65 PSI. Vacuum cover.
Gearhead motor drive, New 1958. Excellent
condition. Stainless construction
throughout.

Inspect In Our Stock

**ME MACHINERY AND
EQUIPMENT CO**

123 Townsend St., San Francisco 7, Calif.

CIRCLE W ON READER SERVICE CARD

Look forward with
Confidence — use

GELB

CHEMICAL PROCESS EQUIPMENT

- 4—Sharples type 316 SS nozzjectors with 40 HP explosion proof motors.
- 1—Bird SS 40" suspended type centrifuge complete with perforate basket, plow and motor.
- 3—Dover 2000 gal. steel jacketed reactor.
- 1—Rietz SS pilot plant grinder.

AUTOCLAVES, KETTLES, REACTORS

- 1—Glascote Series HR 1000 gal. glass lined jacketed reactor, complete with impeller type agitator, baffle and drive
- 1—Pfaudler 750 gal. glass lined jacketed reactor
- 2—Pfaudler Series EM 300 gal. glass lined jacketed reactors'
- 1—300 gal. Hastelloy "B" jacketed pressure reactor
- 1—Blaw Knox 300 gal. stainless steel vacuum reactor
- 2—Theo. Walters Hastelloy "B" 300 gal. jacketed reactors
- 4—Pfaudler Series P glass lined jacketed reactors, complete with agitators and drives, 5, 20 and 30 gal.
- 1—Van Alst 300 gal. stainless steel jacketed kettle
- 2—Blaw Knox steel autoclaves, 600 gal.
- 1—Alloy Fabricators steel jacketed autoclave, 600 gal.
- 1—125 gal. stainless steel jacketed autoclave with impeller type agitator and drive, 125 psi jacket, 75 psi internal
- 2—Stainless steel 2000 gal. horizontal storage tanks
- 1—Patterson-Kelley stainless steel jacketed 1000 gal. reactor
- 1—Glascote 750 gal. glass lined jacketed vacuum receiver

CENTRIFUGES

- 1—Tolhurst type 316 stainless steel 48" Batch-O-Matic centrifuge, NEW
- 1—Fletcher 48" stainless steel underdriven centrifuge, complete
- 1—AT&M 26" type 316 SS suspended type centrifuge, complete
- 5—Tolhurst 40" and 30" rubber covered centrifuges
- 1—Sharples type 316 SS Super-D-Canter, PN-14, complete
- 1—Sharples type 316 SS centrifuge, Model D-2
- 1—Sharples Super-D-Hydrator, monel, Model C-27

DRYERS

- 2—Louisville 8' x 50' stainless steel rotary dryers
- 1—Bullovak 24" x 36 chrome plated double drum dryer
- 1—Allis Chalmers stainless steel rotary dryer, 6' x 50'
- 10—Allis Chalmers rotary dryers, 6' x 50' and 7' x 60'
- 1—Bullovak stainless steel jacketed rotary vacuum dryer, 5' x 30'
- 1—Link Belt steel roto louvre dryer, Model 207-10
- 1—Link Belt steel roto louvre dryer, Model 502-20
- 1—American 42" x 120" double drum dryer, ASME, complete
- 1—Bullovak steel jacketed rotary dryer, 3' x 15'
- 2—Stainless steel pilot plant spray dryers

FILTERS

- 2—Oliver stainless steel rotary filters, 3' x 2' and 3' x 4'
- 12—Sweetland #12 pressure leaf filters with 72 stainless steel leaves
- 1—Niagara stainless steel filter, Model 510-28
- 1—Sperry 36" x 36" heresite covered filter press, 40 chambers
- 10—Shriver plate and frame filter presses, 12" to 42"



THE GELB GIRL — AUGUST 1961


MIXERS

- 1—Abbe 10 gal. steel double arm sigma blade jacketed mixer
- 1—J. H. Day 200 gal. stainless steel double arm sigma blade jacketed mixer
- 3—Sprout Waldron 30 cu. ft. jacketed double ribbon blenders, steel
- 1—Gemco stainless steel double cone jacketed blender, 69 cu. ft.
- 1—Stokes stainless steel granulator, Model 43B
- 1—Sturtevant #7 dustite rotary batch blender, NEW
- 15—Robinson type 304 SS horizontal blenders, 255 cu. ft.
- 1—Robinson type 304 SS horizontal blender, 125 cu. ft.
- 1—Baker Perkins 150 gal. dispersion type mixer, complete
- 1—J. H. Day 5 gal. double arm sigma blade mixer, stainless steel
- 1—Stokes stainless steel granulating mixer, Model 21-J
- 1—Patterson-Kelley stainless steel twin shell blender, 2 cu. ft.

MISCELLANEOUS

- 1—Cleaver Brooks 500 HP package steam generator, 200 #
- 1—Cleaver Brooks 150 HP package steam generator, 150 psi
- 1—Superior 300 HP package, steam generator, 125 psi
- 1—Sprout Waldron pelletizer, Type 501FF
- 1—Williams "Comet" 4 roll mill, complete
- 1—Raymond 2 roll high side mill
- 1—6" x 14" Ross 3 roll paint mill, high speed, complete
- 1—Vulcan stainless steel bubble cap column, 4' dia. x 25 plates
- 1—Griscom Russell stainless steel heat exchanger, 900 sq. ft.
- 3—Badger stainless steel heat exchangers, 500 sq. ft. and 600 sq. ft.
- 4—Patterson stainless steel condensers, 200 and 300 sq. ft.
- 20—Davis Engineering stainless steel heat exchangers, 102, 119, 136, 166 sq. ft., NEW
- 1—Pfaudler glass lined thimble condenser, 62 sq. ft.
- 3—Pfaudler glass lined thimble type condensers, 9 and 14 sq. ft.
- 1—Struthers Wells stainless steel 1150 sq. ft. single effect evaporator
- 2—Mikro #3TH stainless steel pulverizers, complete
- 2—Mikro Bantam pulverizers

- 1—Pfaudler Series R 1500 gal. glass lined jacketed reactor complete with agitator and drive.
- 3—Mikro #3TH stainless steel pulverizers.
- 150—Worthington and Durimet 20 centrifugal pumps, all sizes
- 3—Western States type 316 SS 40" suspended type centrifuges complete with perforate baskets, plows and motors.



R. GELB & SONS, INC.

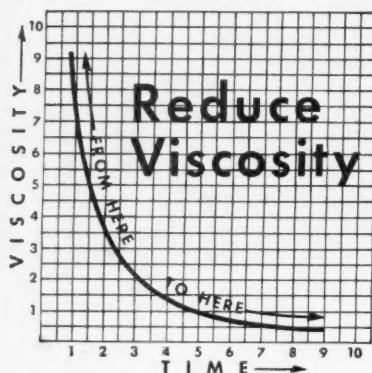
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75

ANNIVERSARY

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Speed Handling OF HEAVY STICKY MATERIALS



The best method for making heavy, viscous materials flow more freely is to apply heat—and the best way to apply heat is through Parks-Cramer jacketed piping, valves and fittings. It is axiomatic that the greater the heating surface, the faster the heating; and, the less viscous the product becomes, the easier it is to handle. These conditions are met by full jackets completely surrounding all product wetted surfaces—thus utilizing maximum heat transfer area.

Parks-Cramer jacketed equipment is also designed with large radii internal contours, extra metal thickness in walls and flanges, jacket tappings amply sized and properly located—all combined to give highest efficiency to viscous fluid handling.

The largest selection of jacketed piping accessories is available in materials ranging from semi-steel (in stock) to carbon and alloy steel, bronze, aluminum, Ductile Iron, Ni-Resist, and plastic lined in sizes from 1¼" to 8". Complete facilities including engineering, scheduling, and installation as well as unit sales are available.

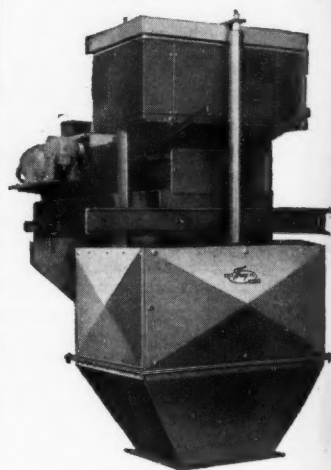
Send for Catalog 356 and supplement 356-S for complete details.



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stay competitive with accurate Thayer scales

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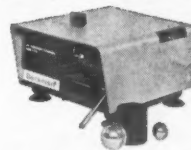
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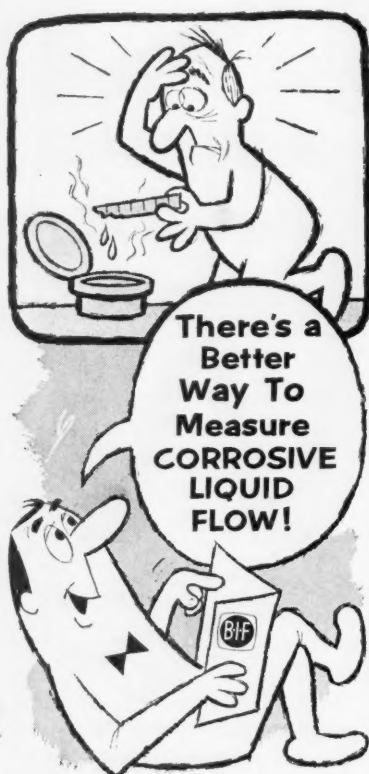
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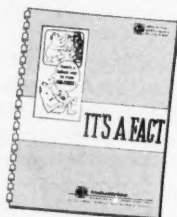
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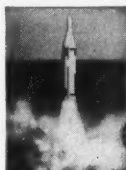
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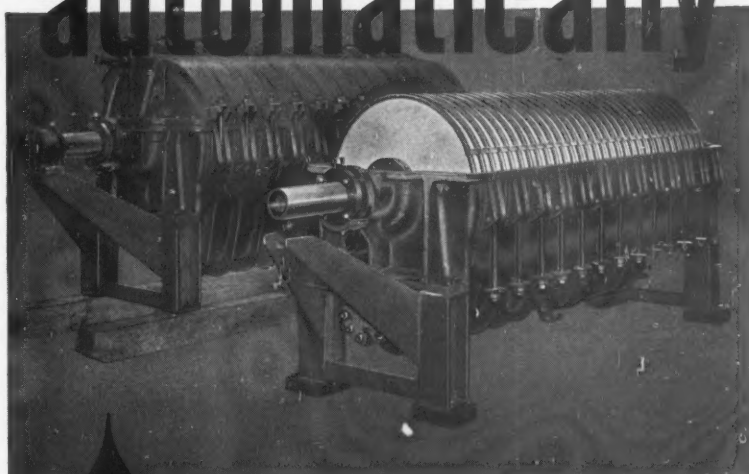
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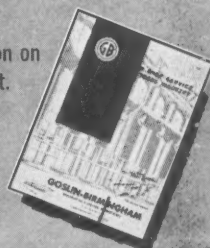


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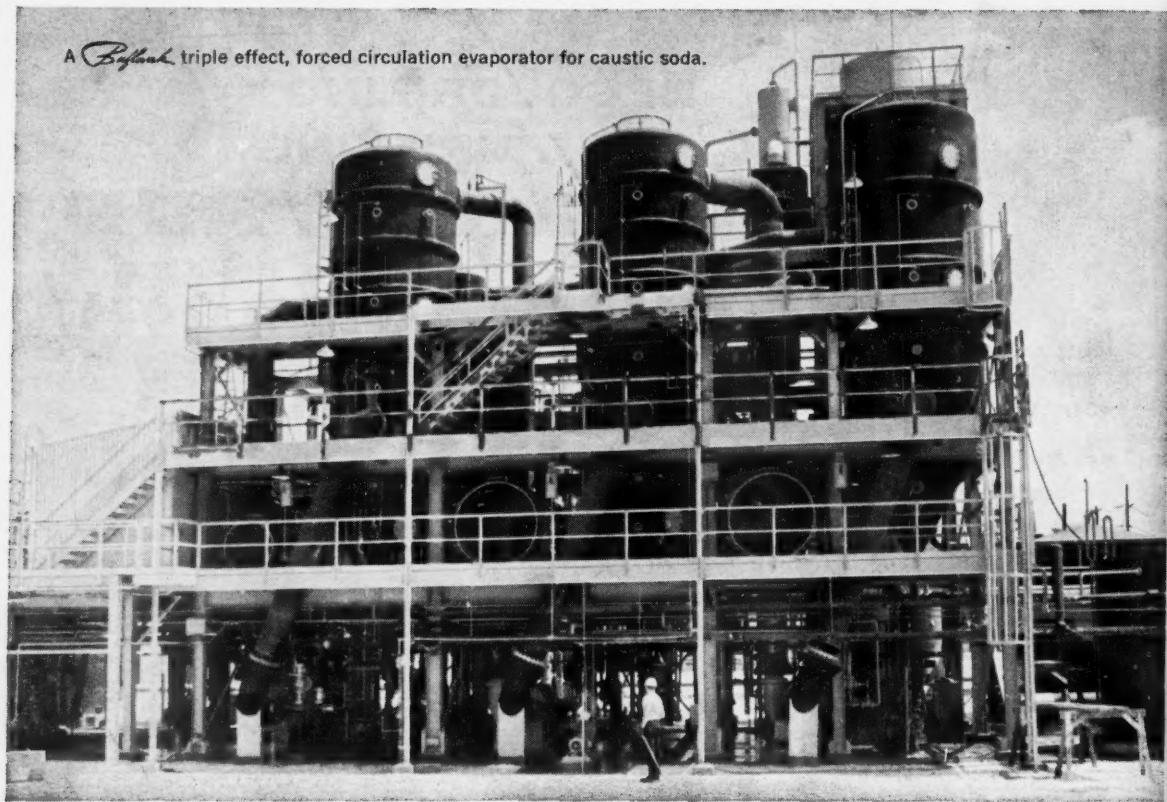
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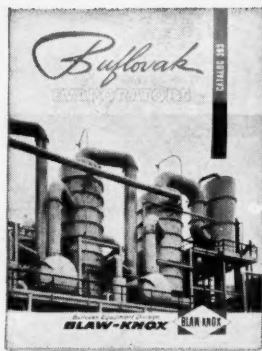
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